Anritsu

OPERATION AND SERVICE MANUAL

OPTICAL POWER METER

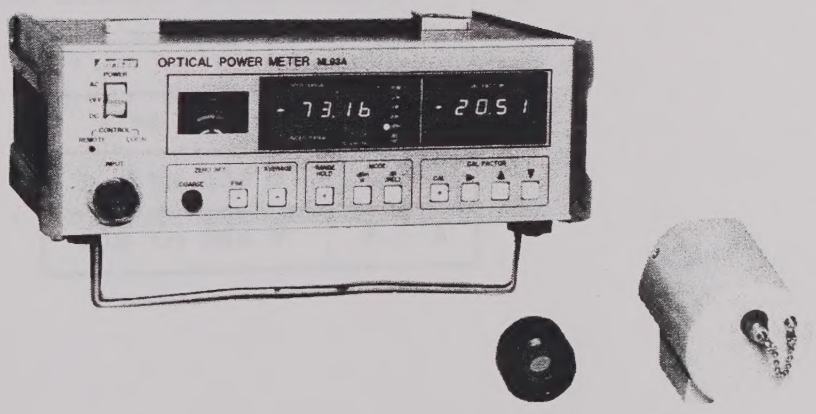
ML93A

ANRITSU ELECTRIC CO., LTD.

TOKYO, JAPAN

OPERATION AND SERVICE MANUAL

OPTICAL POWER METER
ML93A



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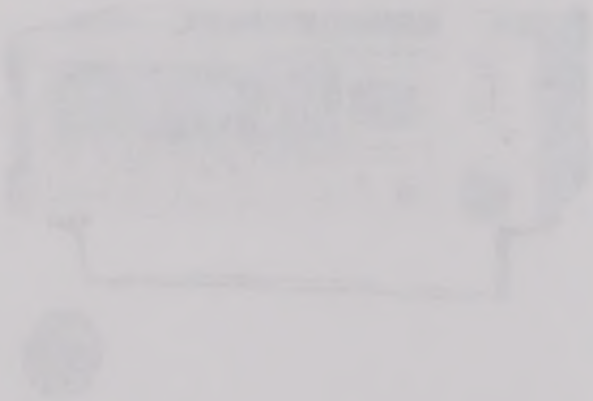

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N O T E

(1) The instrument is operable on a nominal voltage from 100 to 130 Vac or from 200 to 260 Vac by changing the connections of the power transformer taps.

The voltage and current rating are indicated on the rear panel when the instrument is shipped from the factory.

In the case of other voltage operation, change the connections of the power supply transformer, and the plate of voltage and current designations on the rear panel should be changed to suitable one.
Order the plates to Anritsu Electric Co., Ltd. if necessary.

(2) In this manual, a power supply voltage and current rating are represented by [**] Vac and [*] A.

(3) The relation between power supply voltage and current rating is listed below.

** Vac	* A
100 to 130 V	0.5 A
200 to 260 V	0.2 A

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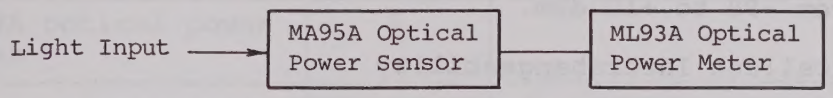
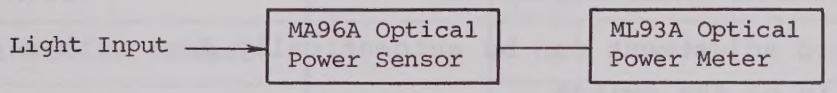
SECTION 1 GENERAL

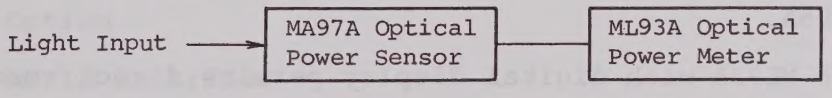
The ML93A Optical Power Meter is designed to measure optical power in conjunction with the MA95A/MA96A/MA97A/MA98A Optical Power Sensor. The combinations of the Meter and the Sensor are shown as follows.



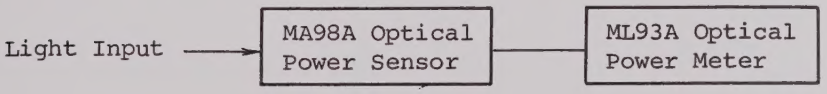
(a) Measures Low-Level Optical Power in the 0.85 μm Band



(b) Measures Low-Level Optical Power in the 1.3 μm Band



(c) Measures High-Level Optical Power in the 0.85 μm Band



(d) Measures High-Level Optical Power in the 1.3 μm Band

Fig. 1-1 Combinations of the Meter and the Sensor

Features

- Wide Wavelength Range

  Two optical power sensors cover a wavelength range from 0.38 to 1.8 μm.

- Wide Power Measuring Range

  Two optical power sensors cover a wide range of power from -90 to +10 dBm.

- Excellent Interchangeability

  The power meter can be connected to any optical power sensor without readjustment.

- Automatic Zero Adjustment

  Zero adjustment can be automatically done with a single flip of the switch.

- Battery Operation

  The ML93A can be operated on an external Battery Pack MZ95A.

- The ML93A with digital display permits direct reading of measurements with high accuracy.

SECTION 2 COMPOSITION AND SPECIFICATIONS

2.1 Standard Composition

Table 2-1 Standard Composition

Name	Quantity	Remarks
ML93A optical power meter	1	
Connecting cord for MA95A/96A	1	2 m, 16-pin connector
Connecting cord for MA97A/98A	1	2 m, 6-pin connector 16-pin connector
Instruction manual	1	
Fuses	1 set	1 set: 2 A ..... 1, * A 1

2.2 Option

GP-IB interface

2.3 Optional Accessories

Name	Remarks
MA95A optical power sensor	
MA96A optical power sensor	
MA97A optical power sensor	
MA98A optical power sensor	
Connecting cord for MA95A/96A	1.7 m, 16-pin connectors
Connecting cord for MA97A/98A	1.7 m, 6-pin connector, and 16-pin connector
Accessory Box	
Connector adapter	D3 connector
MP91A/91B optical fiber adapter	Connector adapter
MP92A Connector adapter	
MP93A Fiber adapter	
MP94A Adapter for MP93A	
GP-IB cord	1 m
Conversion, Connector	GP-IB ⟶ IEC-IB conversion
MZ95A battery pack	
MZ96A battery charger	
DC POWER SUPPLY cord	

Table 2-2 Specifications

		Optical Power Meter ML93A			
Sensor	Model	MA95A	MA96A	MA97A	MA98A
	Wavelength range	0.38 to 1.15 μm	0.75 to 1.8 μm	0.38 to 1.15 μm	0.75 to 1.8 μm
	Element	Si photo diode	Ge photo diode	Si photo diode	Ge photo diode
	Active area diameter	—	—	D = 11.3 mm	D = 5 mm
	Input type	connector		Photo diode	
	Dimensions and weight	65 ø, 85 L mm ≦ 0.7kg		35 ø, 27L mm ≦ 0.1 kg	
Indicator	Model	ML93A			
	Display	Selection among Watts/dBm/dB (REL) Four digits and a small analog meter			
	Calibration coefficient	Front-panel adjustment			
	Recorder output	For each range,1V corresponding to full-scale and 0.316V to -5dB			
	Relative value display	Digital 4 digits			
	Averaging	ON/OFF switchable			
	Dimensions and weight	282W, 99H, 200D mm ≦ 3.5 kg			
Overall	Power measuring range	-90 to 0 dBm (at 0.85 μm) 9 ranges	-80 to 0 dBm (at 1.3 μm) 8 ranges	-65 to +10 dBm (at 0.85 μm) 7 ranges	-40 to +10 dBm (at 1.3 μm) 5 ranges
	Accuracy	±5% (0.85 μm, -10 dBm)	±5% (1.3 μm, -10 dBm)	±5% (0.85 μm, -10 dBm)	±5% (1.3 μm, -10 dBm)
	Resolution	Watts display: 0.1 to 1% dBm display : 0.01 dB			
	Power	** V ±10%, 50/60 Hz, ≦20 VA or Battery Pack MZ95A			

SECTION 3 PRINCIPLES OF OPERATION

3.1 General

There are two types of circuits used in the ML93A optical power meter. One circuit uses an optical modulation method with an optical chopper. This circuit is used with the MA95A or 96A optical power sensor. The other circuit employs a direct detection method which does not require an optical chopper. This circuit is used with the MA97A or 98A optical power sensor. Light input power is converted into electric power and displayed digitally by the ML93A optical power meter.

3.2 Optical Power Sensor

3.2.1 MA95A and 96A Optical Power Sensors

The MA95A uses a silicion photodiode and the MA96A employes a germanium photodiode as the photoelectric conversion element. Fig.3-1 shows a block diagram of the optical power meter. The light input power from the light connector ① is focused by the lens ② on a shading plate on the tuning fork ③. The collimated light is interrupted by the tuning fork with a repetition frequency of approx. 270 Hz and then concentrated on the photodiode ⑤ by the lens ④. It is converted into photoelectric current and then converted further into voltage by the current-to-voltage conversion circuit ⑥, which is an operational amplifier. The conversion circuit ⑥ controls the gain according to the input optical power level over three ranges, 0 to -30 dBm, -30 to -60 dBm and -60 to -90 dBm to expand the dynamic range of the optical power sensor.

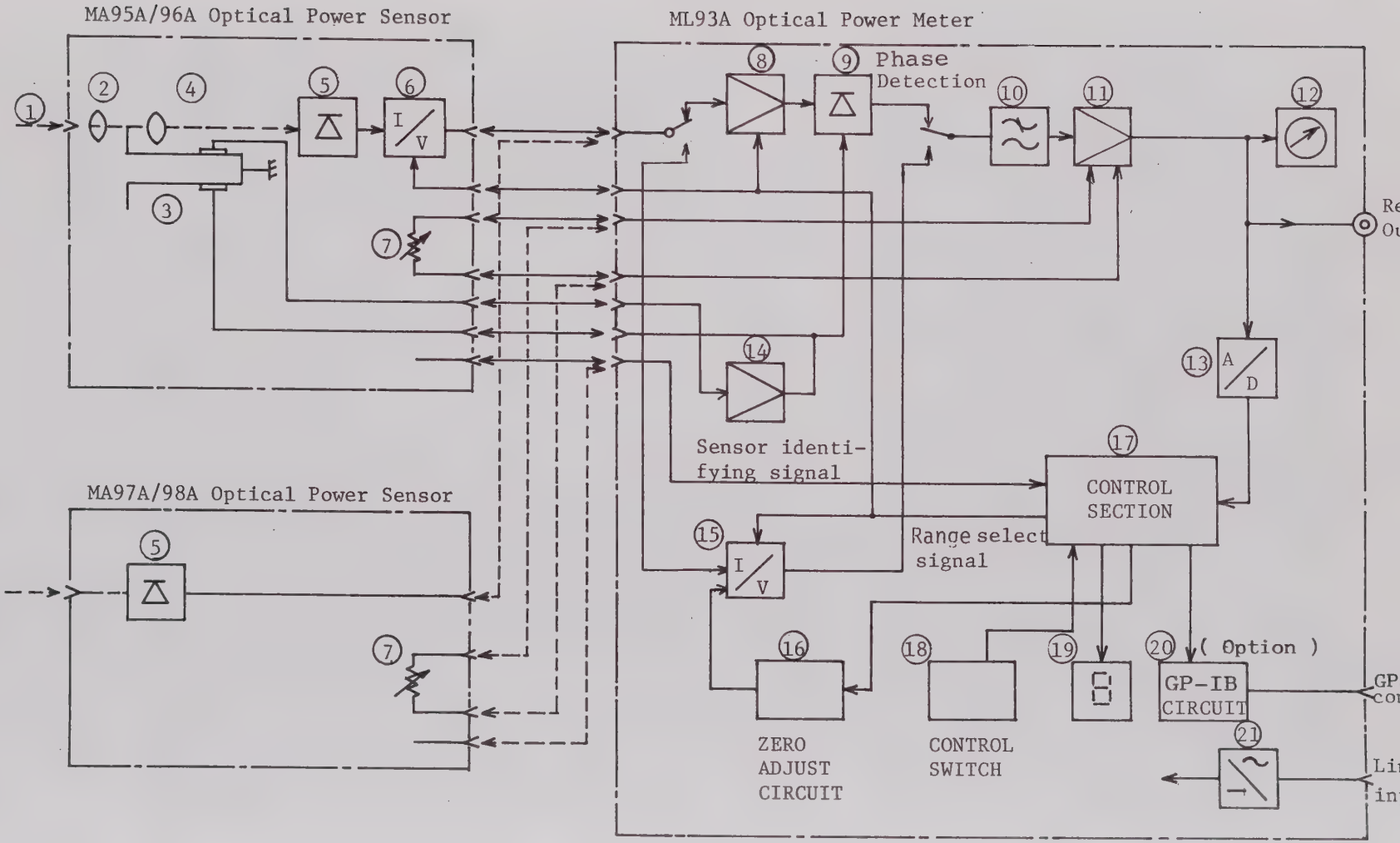


Fig. 3-1 Optical Power Meter Block Diagram

The overall gain in combination with the optical power meter and optical power sensor is made constant, irrespective of the sensor, by the sensitivity adjustment (7) which compensates for variance in photodiode sensitivity.

3.2.2 MA97A and 98A Optical Power Sensors

The MA97A uses a silicon photodiode and the MA98A uses a germanium photodiode as the photoelectric conversion element. These sensors only contain photodiode (5) and sensitivity adjustment (7) described in Section 3.2.1. The conversion circuit (6) is in the ML93A optical power meter.

3.3 ML93A OPTICAL POWER METER (Indicator)

Indicator displays optical power converted into photoelectric current by the optical power sensor in digital form. Each optical power sensor is given a unique identifier signal by which the control section automatically determines which sensor is currently connected. The control section selects the amplifier circuit (8), phase detection circuit (9) and the tuning fork oscillator circuit (14) when sensor MA95A or 96A is connected. The current-to-voltage conversion circuit (15) and the zero adjusting circuit (16) are selected when MA97A or 98A is connected.

The signal output from a MA95A or 96A sensor is switched to suitable range in the amplifier circuit (8).

It then passes through the phase detection circuit (9) and enters the low-pass filter (10). When the MA97A or 98A sensor is connected, the signal is switched to suitable range in the current-to-voltage conversion circuit (15) before entering the low-pass filter (10).

The variable resitor (7) in each sensor adjusts the gain in the amplifier circuit (11) to adjust sensitivity. The detected signal is digitized by the A/D converter (13), processed in the microprocessor control section (17) and then indicated on the numeric display (19). The detected signal is branched to the signal level meter (12) and to the recorder output (4).

The zero adjust circuit (16) is used to compensate for variations of offset voltage which occur when the MA97A or 98A sensor is connected.

When the GP-IB circuit (20) (option) is connected, the instrument can be controlled externally and measurement results can be output.

SECTION 4 OPERATION

4.1 Controls and Functions

4.1.1 MA95A/96A Optical Power Sensor

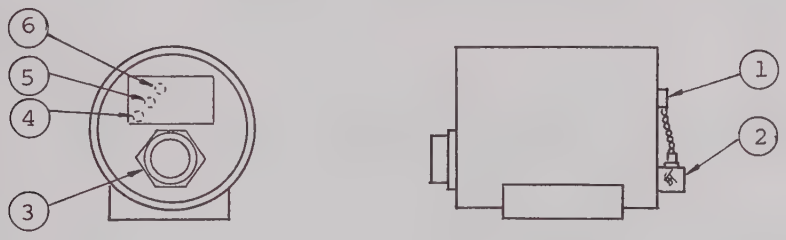


Fig. 4-1 MA95A/96A Optical Power Sensor

(1)	Light input connector :	Attaches the optical fiber connector for measurement.
(2)	Cover :	Cover for (1). Also used for zero adjustment.
(3)	Receptacle :	Connected to the optical power meter with the supplied cord.
(4)	Sensitivity adjustment :	Component No. R14 (located under the label).
(5)	Sensitivity adjustment :	Component No. R8 (located under the label).
(6)	Sensitivity adjustment :	Component No. R11 (located under the label).

4.1.2 MA97A/98A Optical Power Sensor

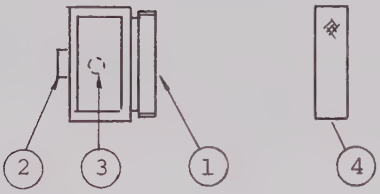


Fig. 4-2 MA97A/98A Optical Power Sensor

(1)	Light input area	:	Receives the light to be measured.
(2)	Receptacle	:	Connected to the optical power meter with the supplied cord.
(3)	Sensitivity adjustment	:	Adjusts the photodiode sensitivity.
(4)	Cover	:	Protects the light input area.

4.1.3 ML93A Optical Power Meter

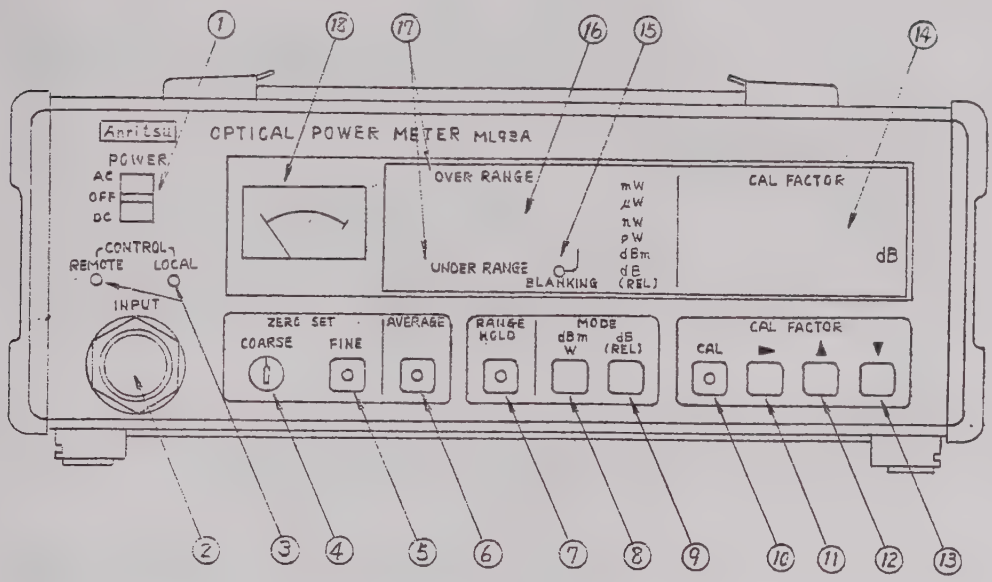


Fig. 4-3 Front Panel

Table 4-1 Front Panel Controls and Functions

No.	Indication	Function
①	Power	Power switch
	AC	AC power supply
	OFF	OFF
	DC	MZ95A battery pack or other external DC power supply
②	INPUT	INPUT receptacle. Socket for connection of optical power sensor cord.

No.	Indication	Function
③	CONTROL REMOTE LOCAL	CONTROL indicators. REMOTE is lit when the meter is operating in remote mode using an external controller through GP-IB. Otherwise, LOCAL is lit.
④	ZERO SET COARSE	Zero adjustment knob ④ and switch ⑤ (see below). Used only when the MA97A/98A optical power sensor is connected. Adjusts zero point when the optical power sensor is changed or if ambient temperature varies greatly. (Coarse adjustment.)
⑤	FINE	The zero point is adjusted automatically when this switch is pressed. • If the MA95A/96A optical power snesors is connected, the zero point is automatically adjusted when this switch is pressed. If the optical power sensor is to be used in the highest sensitivity range, press this swtich after setting the AVERAGING switch ⑥ to ON. • If the MA97A/98A optical power sensor is connected, the zero point is precisely adjusted when this switch is pressed after adjustment with the COARSE knob. The coarse adjustment must be within 10% of the value of the highest sensitivity range used.
⑥	AVERAGE	Averaging ON/OFF switch. When this switch is turned on, the display ⑯ is indicated an integrated value to reduce short-term noise. The LED on the switch indicates whether the averaging function is on or off.
⑦	RANGE HOLD	Automatic Range/Range Hold Selection Switch. When this switch is pressed, the range is held and the LED on the switch comes on. When the switch is pressed again, the automatic range function is restored.

No.	Indication	Function
(8)	MODE dBm W	Watt/dBm selection switch. Measured values can be displayed in units of dBm or watts. The unit can be changed alternately by pressing selection switch. The selected unit of measurement is indicated by the LED on the display (16).
(9)	dB (REL)	When the dB(REL) switch is pressed the LED on the dB(REL) switch comes on, the current measurement value is stored in memory, and the difference between this value and a subsequent measurement value is indicated in dB. The dB (REL) function is released by pressing the dBm/W Switch (8).
(10)	CAL FACTOR CAL	Calibration value set switch The calibration factor can be changed with switches (11), (12), and (13) when the CAL switch (10) is ON. During the CAL switch is on, one of these LEDs on the CAL factor display (14) blinks to indicate a settable digit. After CAL factor setting on the display (14) is finished (refer to the No.(11), (12), (13)), then repress the CAL switch (10). At this time, the LED on the CAL switch goes off. Numeric display (16) indicates the value including this set CAL factor.
(11)	►	The variable digit shifts to the right each time this button is pressed.
(12)	▲	The numeric value of the blinking digit increments each time this button is pressed.
(13)	▼	The numeric value on the blanking digit decrements each time this button is pressed. The sign is alternated from + to - each time either switch (12) or (13) is pressed.

No.	Indication	Function
⑭		CAL factor display: Indicates a 4-digit number and plus (+) or minus (-) sign for polarity of the measured value.
⑮	BLANKING	Suppression switch for the display of the least significant digit of the measured value display ⑯.
⑯		Numeric display: Indicates a 4-digit number and plus (+) or minus (-) sign for polarity of the measured value.
⑰	OVER RANGE UNDER RANGE	The applicable LED lights up to indicate whether the input to be measured is over- or under-range.
⑱		The meter indicates the approximate value of the measurement result.

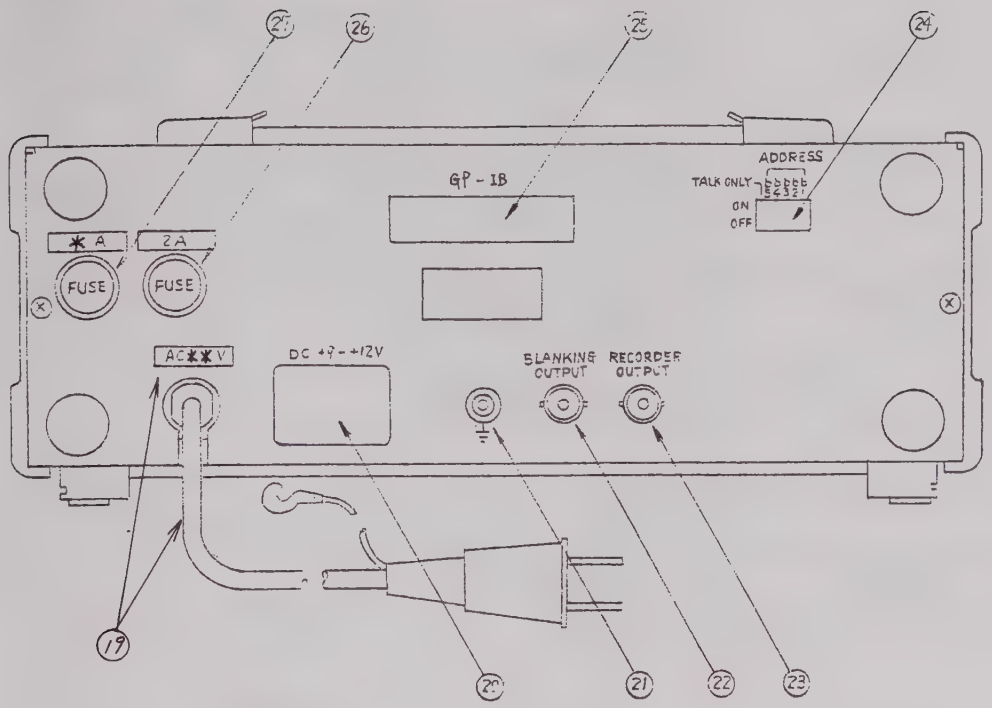


Fig. 4-4 Rear Panel

Table 4-2 Rear Panel Controls and Functions

No.	Indication	Function
(19)	AC ** V	ac power cord
(20)	DC +9 – +12 V	Input connector for MZ95A battery pack or external dc power supply. The instrument is connected to an external DC power supply with an optionally supplied cord. Supply voltage between +9 and +12 V is required. And then DC power is supplied when power switch (1) is set to the DC position.
(21)	⏚	Ground terminal. Should be well-grounded.

No.	Indication	Function
㉒	BALNKING OUTPUT	Grounded during zero adjustment with open collector output.
㉓	RECORDER OUTPUT	Recorder output connector. The voltage corresponding to the W (watt) scale is output: 1V corresponding to the full scale and 0.316V to -5dB.
㉔	ADDRESS (option)	Enables address setting when using the GP -IB interface.
㉕	GP -IB (option)	GP -IB connector
㉖	FUSE 2A	dc power supply fuse.
㉗	FUSE *A	ac power supply fuse.

4.2 Measurement

4.2.1 Notes on Measurement

1) Make sure the ground terminal (21) on the rear panel is well-connected to ground.

2) Excessive light input will damage the photodiode. Do not input light exceeding the specified value.

3) When using the instrument in a light place, be careful to avoid interference.

4) Sensitivity will change if the light source is exposed to a place other than the active area of the crystal element. Be careful to place other than the active area of the crystal element. Be careful to place the light source to be measured within the active area of the MA97A/98A optical power sensor when it is used without the connector adapter.

5) If a low impedance circuit or instrument is connected to the recorder output terminal, the recorded value will not be accurate. Use a recorder with an input impedance of at least 100 kΩ.

   The recorder output is not averaged. When measuring low-level light input, insert an appropriate smoothing circuit into the input of the recorder to procedure a record of averaged values.

6) Instrument functions are initialized (refer to 4.2.3 (1)) whenever the power is turned on again after ac power operation is interrupted.

7) If a high-amplitude spike enters through the power line, the instrument may fail to operate normally. Turn the power off and then on again to reinitialize the instrument in such a case.

4.2.2 Power Supply

1) AC Power Supply

Verify that the POWER switch (1) is set to OFF and that the line voltage is ** V ac ±10%. Connect the power cord to the ac line.

2) MZ95A Battery Pack

Verify the POWER switch (1) is set to OFF. Connect the MZ95A battery pack to the connector (20). Refer to the MZ95A Instruction Manual.

3) External DC Power Supply

Verify that POWER switch (1) is set to OFF. Connect the DC power supply to connector (20) with the optionally supplied cord.

4.2.3 Measurement

1) Connect the optical power sensor to the optical power meter and turn on the power.

When the power is turned on, the functions are initialized as follows:

i) Zero adjustment: OFF

ii) Average : OFF

iii) Range : Automatic range (the range with the maximum sensitivity as determined by the optical power sensor)

iv) Mode : dBm

v) CAL switch : OFF

vi) Calibration

Factor : 0.00 dB

2) Shut off any light input using the cover attached to the optical power sensor and press the automatic zero set switch.

After the MA95A/96A optical power sensor is connected, if an accurate zero adjustment is required, turn on the AVERAGE switch (6) and press the ZERO SET FINE button (5). The LED lights up and goes off when the zero adjustment is finished, in approximately 3 seconds.

When the MA97A/98A optical power sensor is connected, adjust the numeric display (16) with the ZERO SET COARSE knob (4) so that the displayed value is below 10% of the highest sensitivity range and press the ZERO SET FINE button (5). The LED goes off in approxiately 20 seconds after the completion of zero adjustment.

3) Set the CAL FACTOR, MODE, RANGE HOLD switches as required and input the light to be measured.

The measurement result is displayed on the numeric display (16) in 4 digits from 0.00 to 99.99 with a sign digit. The approximate value of the measurement is indicated by the meter (18).

Press the BLANKING switch (15) to suppress the least significant digit.

4) Refer to Section 5 below for information remote control using the GP-IB option.

5) The response of the optical power sensor varies at different wavelengths. The detection response of MA95A and MA97A is calibrated at the 0.85 μm wavelength and MA96A and MA98A are calibrated at 1.3 μm. Therefore, responsivity compensation is required when measuring optical power at wavelengths other than those given above. Sensor responsivity - wavelengths curves can be supplied on request (option).

Responsivity variations are compensated for in the manner described below. If the responsivity of MA95A at 1 μm is -1dB, set the CAL FACTOR to "-1.00" when measuring optical power at 1 μm, the measured value will be accurately compensated.

SECTION 5 GP-IB (OPTION)

5.1 General

The GP-IB interface option satisfies all standard specifications for GP interface bus. Programmable automatic measurements can be carried out with any controller conforming to specifications for an GP interface bus. When this option is connected to a data output device, such as a printer, which has a listener function, a record of measured power can be obtained.

5.2 Interface Functions

The GP-IB has the following functions:

Function	Description
SH1	Complete source handshake functions
AH1	Complete acceptor handshake functions
L4	Basic listener function The listener function can be released by MTA.
T5	Basic talker function Serial pole function Talk-only mode The talk function can be released by MLA.
SR0	Not including the service request function
RL1	Including the remote operation/local operation selecting function
PP0	Not including the parallel pole function
DC0	Not including the device clear function
DT0	Not including the device trigger function
C0	Not including the control function

Note: The POWER switch and the COARSE ZERO knob on the front panel of the ML93A optical power meter are enabled during remote operation.

5.3 Programming Codes

All programming codes are ASCII codes.

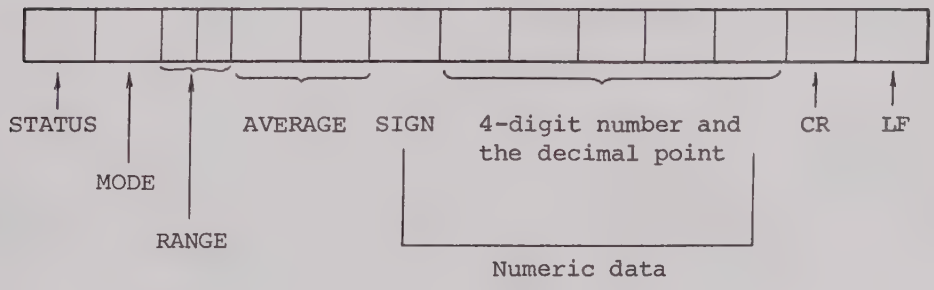
(a) Input Programming Codes

Function	Contents	Programming Code
RANGE specification	RANGE HOLD: +10 dBm (10 mW) range	A0
	RANGE HOLD: 0 dBm (1 mW) range	A1
	RANGE HOLD: -10 dBm (100 µW) range	A2
	RANGE HOLD: -20 dBm (10 µW) range	A3
	RANGE HOLD: -30 dBm (1 µW) range	A4
	RANGE HOLD: -40 dBm (100 nW) range	A5
	RANGE HOLD: -50 dBm (10 nW) range	A6
	RANGE HOLD: -60 dBm (100 pW) range	A7
	RANGE HOLD: -70 dBm (100 pW) range	A8
	RANGE HOLD: -80 dBm (10 pW) range	A9
	AUTO RANGE	B
Display mode	WATT display	C0
	dBm display	C1
	dB (REL) display	C2
CAL. FACTOR	CAL. FACTOR data format	D, +or-, [ ][ ][ ][ ] CAL. FACTOR 4 digits The decimal point is assumed to be in the third digit location. Example: 1234 = 12.34
AVERAGING	AVERAGING ON	E0
	AVERAGING OFF	E1
ZERO SET (FINE ZERO)	ZERO SET ON	Z

Function	Contents	Programming Code
Measurement rate	HOLD (No measurement)	F0
	FREE RUN (Continuous measurements at the same rate as operations of key switchs on the front panel.)	F1
	EXT TRIGGER (Switched to HOLD MODE after each measurement)	F2

(b) Output Data Format

This option outputs data in the format shown below:

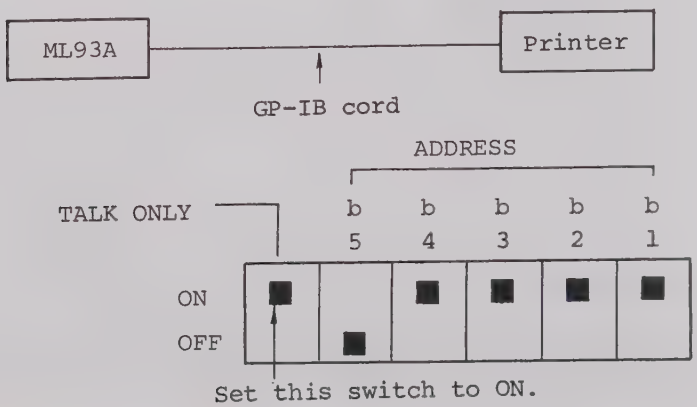


Function	Contents	Programming Code
STATUS	OVER RANGE	V
	UNDER RANGE	W
	IN RANGE	X
MODE	mW	P
	μW	Q
	nW	R
	pW	S
	dBm	T
	dB (REL)	U

Fuction	Contents	Programming Code
RANGE	RANGE HOLD: +10 dBm (10 mW) range	A0
	RANGE HOLD: 0 dBm (1 mW) range	A1
	RANGE HOLD: -10 dBm (100 µW) range	A2
	RANGE HOLD: -20 dBm (10 µW) range	A3
	RANGE HOLD: -30 dBm (1 µW) range	A4
	RANGE HOLD: -40 dBm (100 nW) range	A5
	RANGE HOLD: -50 dBm (10 nW) range	A6
	RANGE HOLD: -60 dBm (1 nW) range	A7
	RANGE HOLD: -70 dBm (100 pW) range	A8
	RANGE HOLD: -80 dBm (10 pW) range	A9
	AUTO RANGE	AB
AVERAGE	With AVERAGING	E0
	Without AVERAGING	E1
Sing for measured value	Positive	+
	Negative	-

5.4 Instructions for Operation

(a) When using the power meter with a data output device having a listener function, set the ADDRESS switch on the rear panel to TALK ONLY mode (refer to the diagram below).



(b) When Connected to a Controller for Programmable Automatic Measurement

Set the device address with the ADDRESS switches b1 to b5 on the rear panel. The address set shown in the example is 15. Set the TALK ONLY switch to OFF.

If the Anritsu DDC7705A personal computer or DPR7710A printer is being used, the following table is applicable.

Measurement Method	Program Example	Remark
FREE RUN (Continuous measurement)	0 FORMAT "C12" 1 READ #115: 0, A$ 2 PRINT A$ 3 GOTO 1 4 END	FREE RUN MODE when ML93A power is turned on.
EXT TRIGGER (Single measurement)	0 FORMAT "C12" 1 CMD #115, "?P/";"F2" 2 READ #115: 0, A$ 3 PRINT A$ 4 END	? → UNL P → TALK ADDRESS of controller. 1 → LSN. ADDRESS of ML93A
Others	REN #115	REMOTE operation. Switches on the front panel are disabled.
	LCL #115	LOCAL operation.

Notes:

1. ZERO SET operation requires the time indicated below.
   20 seconds for MA97A/98A
   3 seconds for MA95A/96A

2. Maximaly 5 seconds is required for the measured value to stabilize after RANGE is switched.

SECTION 6

CALIBRATION AND ADJUSTMENT

6.1 General

This section describes the method of calibration and adjustment, and general maintenance of the ML93A. Table 6-1 shows the method of general maintenance, and Table 6-2 shows the instruments required for calibration and adjustment.

Table 6-1 General Maintenance

Check	Period	Procedure
Dirt	◦ Before storing for an extended period of time	Wipe off with industrial cleaning solvent
Dust, etc.	◦ When used in a dusty environment ◦ When dirt is noticeable	Remove the cover and blow out with compressed air
Lubrication	Unnecessary	
Loose knobs screws	When found	Retighten

Table 6-2 Instruments Required for Calibration and Adjustment

Name of Instrument	Major Specifications	Required for
DC voltage standard	Output voltage: 0 to 50 V Resolution : 1 mV	Power source amplifier section of the ML93A
Oscilloscope	Frequency range : DC to 50 MHz	Power source amplifier and Control sections of the ML93A Optical power sensor
Multimeter	Sensitivity : 1 μV Input resistance : 10 MΩ	ML93A Optical power sensor
Light source	Output : ≧-5 dB Wavelength : 0.85 μm, 1.3 μm	Optical power sensor
Optical attenuator	Attenuation : ≧60 dB Resolution : 0.01 dB	Optical power sensor
Optical power meter	Measuring range : 0 to -65 dBm Measuring wavelength : 0.85 μm, 1.3 μm	Optical power sensor

6.2 Adjustment Procedure

6.2.1 ML93A Sensitivity Adjustment Procedure

This instrument is used in conjunction with any of two types of optical power sensors which may be classified roughly as either high sensitivity optical power sensor (MA95A/96A) or high power optical power sensor (MA97A/98A), and required adjustments suited for the respective use. Adjust the ML93A by the adjustment procedure shown in Table 6-3.

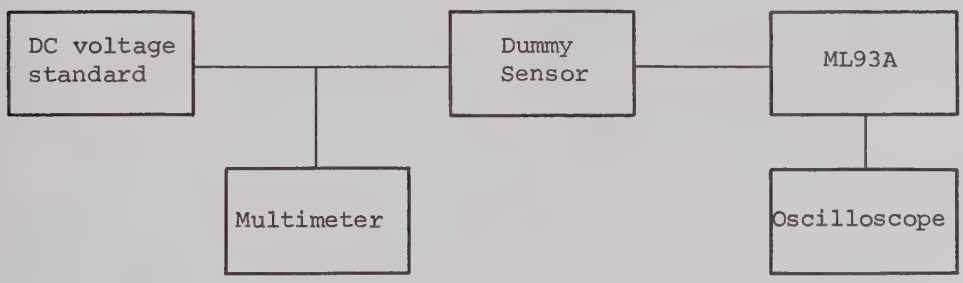


Fig. 6-1 Block Diagram for ML93A Calibration and Adjustment

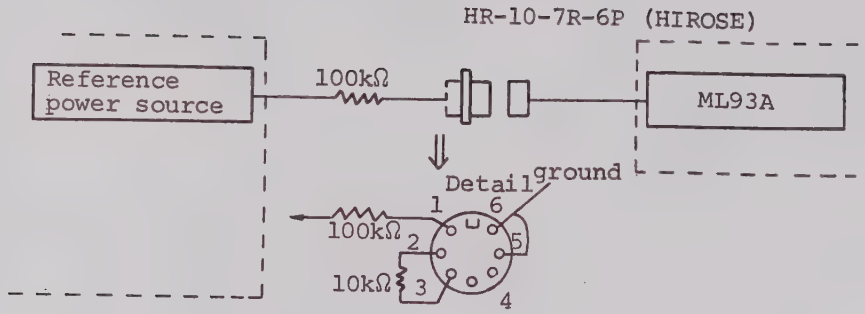
Table 6-3 Adjustment Procedure

	Setting	Adjustment Procedure	Remarks
High level circuit	∘ Set the DC voltage standard output voltage to 0 V. Connect terminal Q13-3 to analog ground (See Fig. 7-9)	∘ Adjust R34 to make the voltage at Q13-6 0 V. ∘ Adjust R84 to make the voltage at Q25-6 0 V.	Power source, amplifier section P.C. board (Refer to Fig. 7-9)
	∘ Set the DC voltage standard output voltage to 0 V. ∘ Check the adjustment range of COARSE ZERO and set it in the vicinity of 0.	∘ Adjust R77 to make the adjustment range of COARSE ZERO -5 nW to +5 nW.	Power source, amplifier section P.C. board (Refer to Fig. 7-9)
	∘ Set the DC voltage standard output voltage to -50 V.	∘ Adjust R25 to make display +1.000 mW at the display.	Control section P.C. board (Refer to Fig. 7-6)
		∘ Adjust R85 to make recorder output voltage 1 V. ∘ Adjust R87 to make the meter needle deflect to the position shown below. 	Power source, amplifier section (Refer to Fig. 7-9)
	∘ Set the DC voltage standard output voltage to 0 V.	∘ Adjust R39 and R50 to make the voltage at output terminal (red) of T1 35 to 40 Vp-p. (Tuning fork oscil-oscillation level)	Power source, amplifier section P.C. board (Refer to Fig. 7-9)
	∘ Set the DC voltage standard output voltage to 0.29 V.	∘ Use R43 to adjust the phase of the output at Q8-6.	Power source, amplifier section P.C. board (Refer to Fig. 7-9)

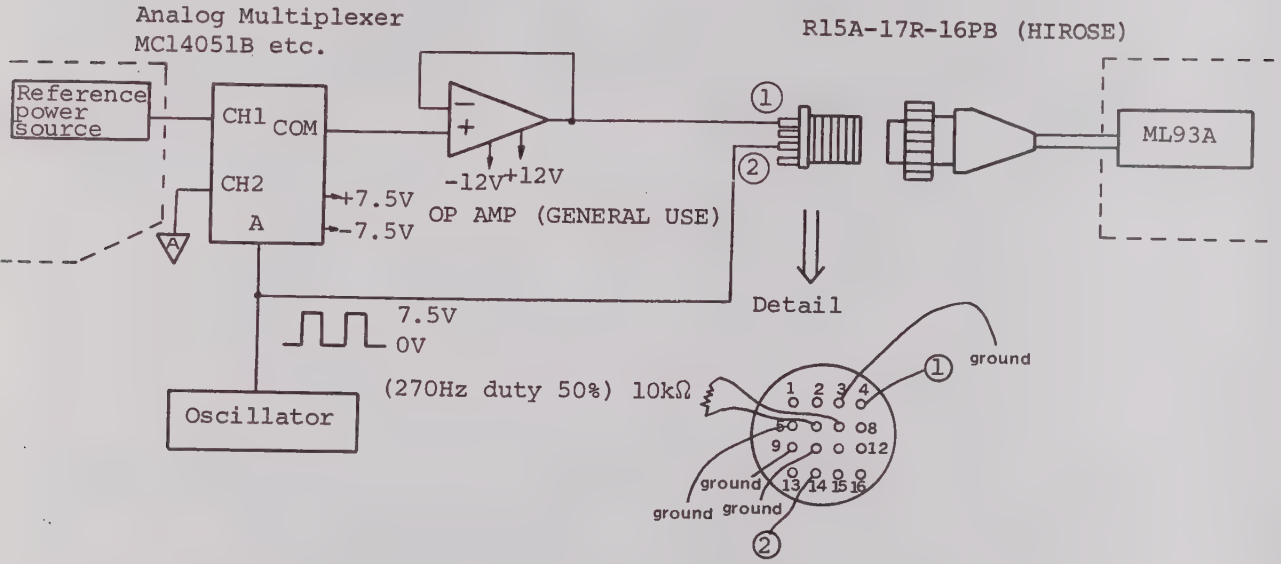
Table 6-3 Adjustment Procedure (Cont'd)

	Setting	Adjustment Procedure	Remarks
	∘ First set the DC voltage standard output voltage to 0.003 V and set RANGE HOLD to ON. Next set the DC voltage standard output voltage to 0 V and set MODE to W.	∘ Adjust R81 to make display 0 ±0.01 μW at the display.	Power source, amplifier section P.C. board (Refer to Fig. 7-9)
	∘ Set the DC voltage standard output voltage to 0.290 V.	∘ Adjust R108 to make display 100.0 μW at the display.	Power source, amplifier section P.C. board (Refer to Fig. 7-9)

The dummy sensor shown in Fig. 6-1 is a circuit used to provide an input corresponding to the signal from the optical power sensor to the ML93A. Fig. 6-2 shows the circuit diagram.



(a) High level Dummy Sensor (correspond to MA97A)



(b) High sensitivity Dummy Sensor (correspond to MA95A)

Fig. 6-2 Circuit Diagram of Dummy Sensor

6.2.2 Optical Power Sensor Sensitivity Adjustment Procedure

(Refer to Figs. 6-3 to 6-5.)

(1) MA95A/96A

1. Connect the ML93A to the MA95A/96A and confirm that the tuning fork oscillator circuit built in the MA95A/MA96A operates normally. (If it does, the oscillation tone can be heard in the ear brought into direct contact with the MA95A/96A.)

2. As shown in Fig. 6-3, input an optical power to the reference optical power sensor and adjust the optical attenuator so that the ML93A (1) indicates - 60.00 dBm.

3. Input the same optical power as in item 2 to the optical power sensor under calibration and adjust knob (1) shown in Fig. 6-4 to make ML93A (2) indication - 60.00 dBm.

4. Input an optical power to the reference optical power sensor and adjust the optical attenuator sc that the ML93A (1) indicates -30.00 dBm.

5. Input the same optical power as in item 4 to the optical power sensor under calibration and adjust knob (2) shown in Fig. 6-4 to make ML93A (2) indication - 30.00 dBm.

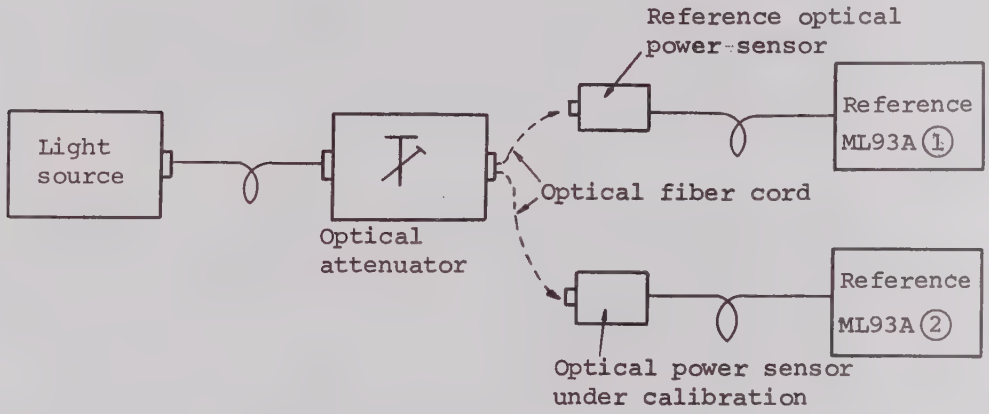
6. Input an optical power to the reference optical power sensor and adjust the optical attenuator so that the ML93A (1) indicates - 10.00 dBm.

7. Input the same optical power as in item 6 to the optical power sensor under calibration and adjust knob (3) shown in Fig. 6-4 to make ML93A (2) indication -10.00 dBm.

(2) MA97A/98A

1. As shown in Fig. 6-3, input an optical power to the reference optical sensor and adjust the optical attenuator so that the ML93A (1) indicates - 10.00 dBm.

2. Input the same optical power as in item 1 to the optical power sensor under calibration and adjust knob (1) shown in Fig. 6-5 to make ML93A (2) indication - 10.00 dBm.



NOTE: Reference ML93A (1) and ML93A (2) are adjusted to the same sensitivity.

Fig. 6-3 Optical Power Sensor Calibration

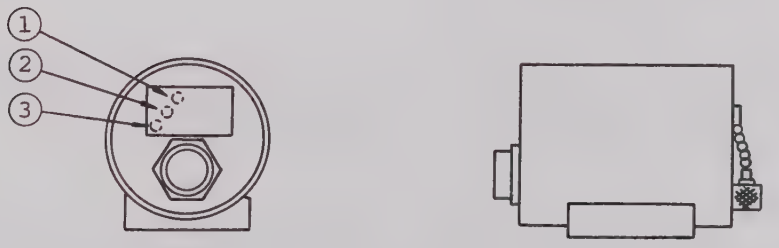


Fig. 6-4 Optical Power Sensor MA95A/96A

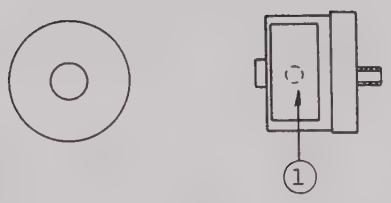


Fig. 6-5 Optical Power Sensor MA97A/98A

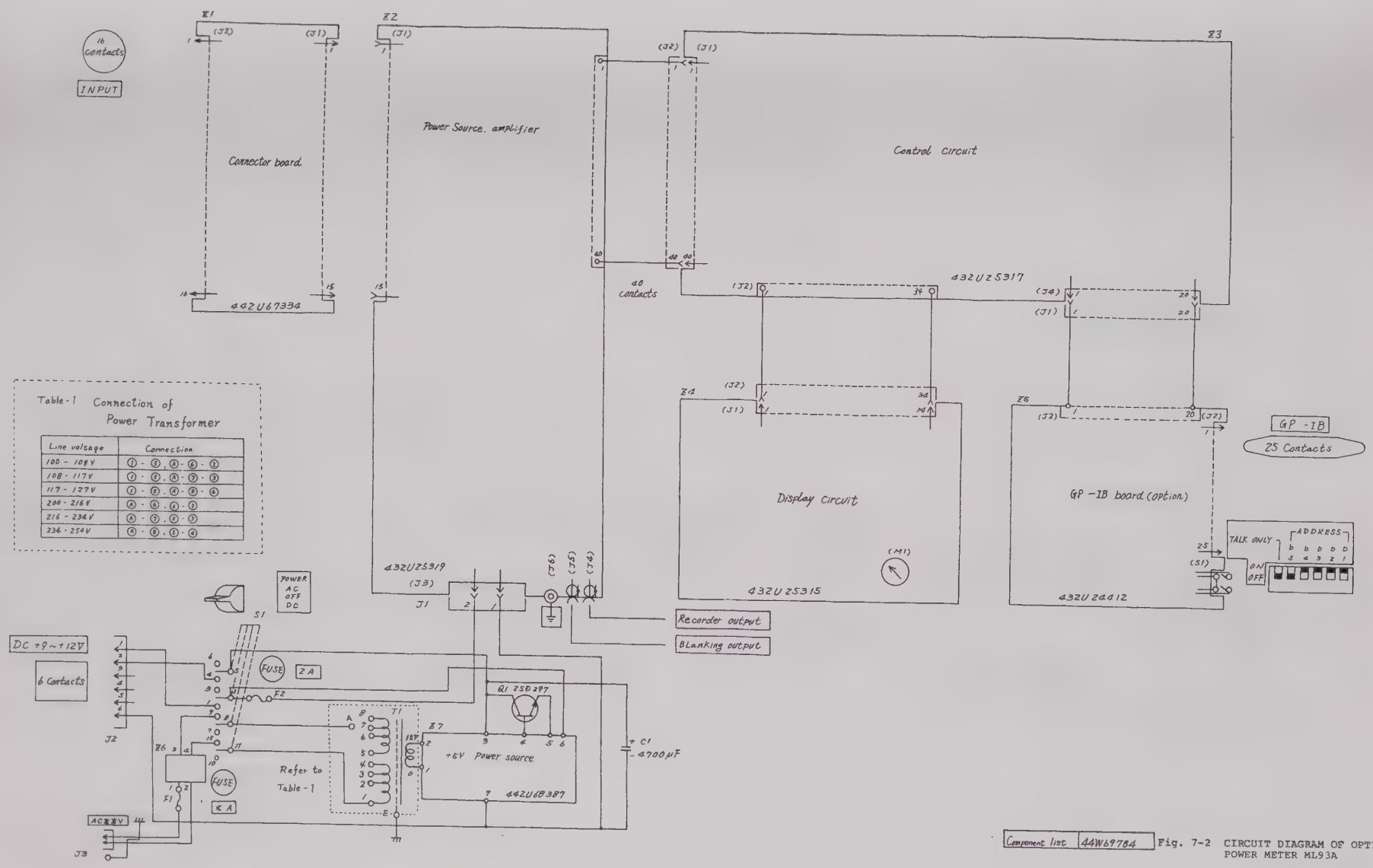
SECTION 7

TROUBLESHOOTING AND REPAIR

In the event that a trouble occurs in this instrument, find the part in which the trouble exists by the procedure shown in the troubleshooting flowcharts in the following and make repairs.

Find the defective printed circuit board by the procedure of the overall troubleshooting flowchart shown in Fig. 7-1, and repair it by reference to each printed circuit board's circuit diagram, printed circuit board components arrangement diagram and test point data (in paragraph 7.2 to 7.4).

If the control P.C. board is defective, it is necessary to replace the P.C. board. However, in the case of a simple defect, make repairs in accordance with paragraph 7.2.



Component list 44W69784

Fig. 7-2 CIRCUIT DIAGRAM OF OPTICAL POWER METER ML93A

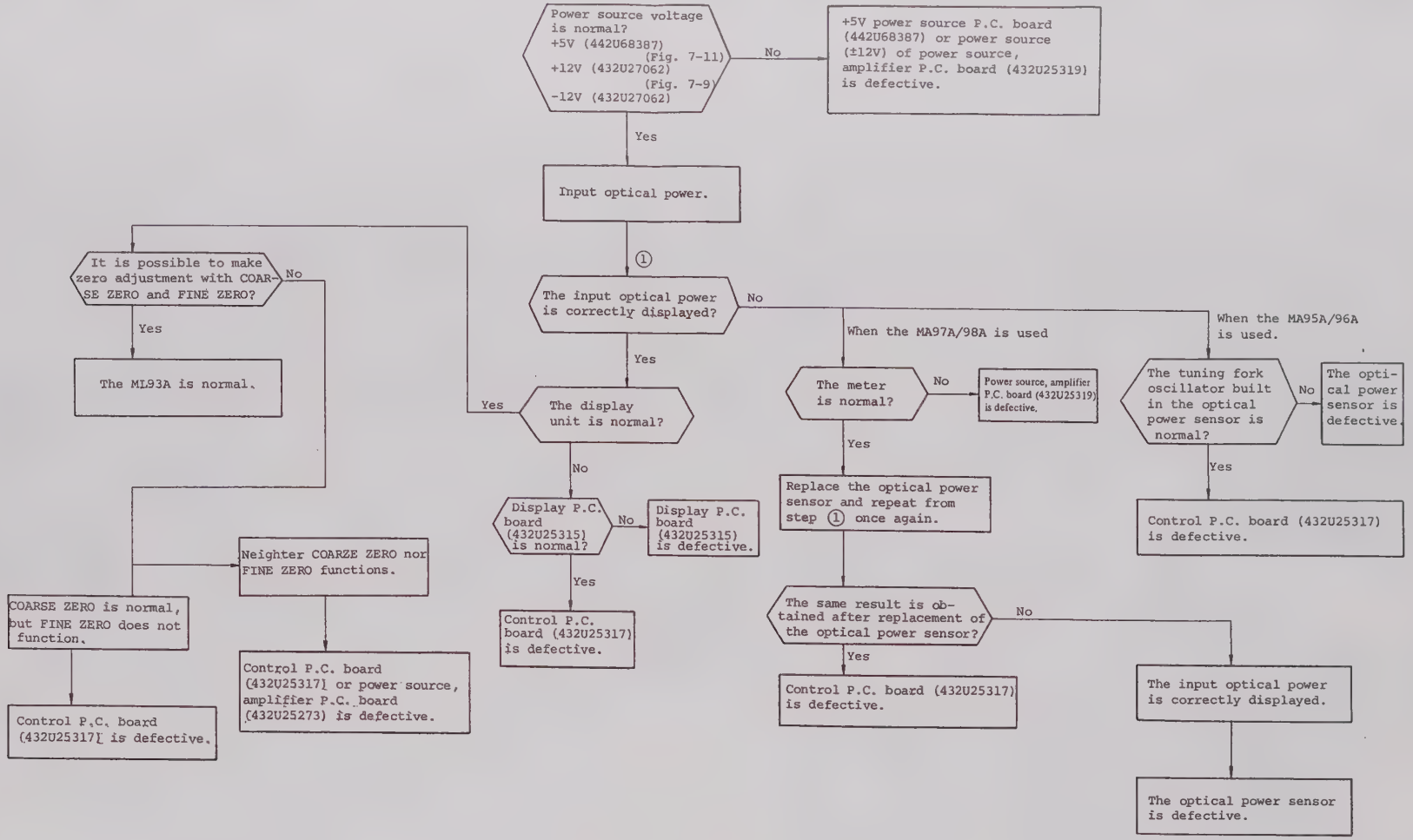

Power source voltage is normal?
+5V (442U68387) (Fig. 7-11)
+12V (432U27062) (Fig. 7-9)
-12V (432U27062)
No
+5V power source P.C. board (442U68387) or power source (±12V) of power source, amplifier P.C. board (432U25319) is defective.
Yes
Input optical power.
①
The input optical power is correctly displayed?
No
When the MA97A/98A is used
When the MA95A/96A is used.
Yes
The display unit is normal?
Yes
No
Display P.C. board (432U25315) is normal?
No
Display P.C. board (432U25315) is defective.
Yes
Control P.C. board (432U25317) is defective.
The meter is normal?
No
Power source, amplifier P.C. board (432U25319) is defective.
Yes
Replace the optical power sensor and repeat from step ① once again.
The same result is obtained after replacement of the optical power sensor?
No
Yes
Control P.C. board (432U25317) is defective.
The input optical power is correctly displayed.
The optical power sensor is defective.
The tuning fork oscillator built in the optical power sensor is normal?
No
The optical power sensor is defective.
Yes
Control P.C. board (432U25317) is defective.
It is possible to make zero adjustment with COARSE ZERO and FINE ZERO?
No
Yes
The ML93A is normal.
Neighter COARZE ZERO nor FINE ZERO functions.
Control P.C. board (432U25317) or power source, amplifier P.C. board (432U25273) is defective.
COARSE ZERO is normal, but FINE ZERO does not function.
Control P.C. board (432U25317) is defective.

Fig. 7-1 Overall troubleshooting flowchart

7.2 Control P.C. Board Troubleshooting

7.2.1 Circuit Description

The control circuit employs a microprocessor to control various parts of the ML93A. Fig. 7-3 shows the block diagram and Table 7-1 shows explanation of control signals.

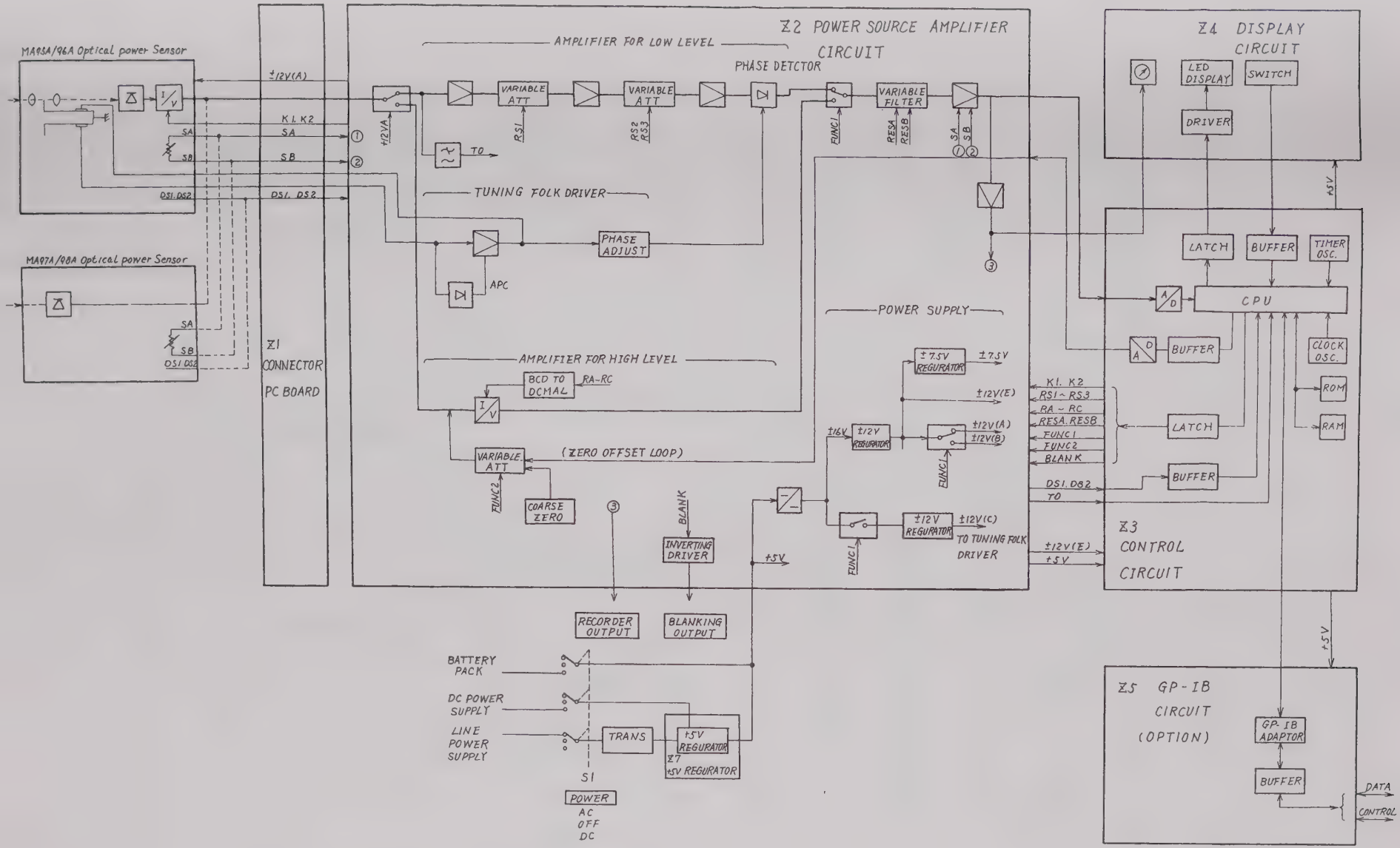


Fig. 7-3 ML93A OPTICAL POWER METER BLOCK DIAGRAM

Table 7-1 Explanation of Control Signals

Regarding range select

Name and Value of signal *	Description
K2 K1	To be used for range select of MA95A/96A
1, 0	0 to -30 dBm ranges To turn on relay K1 in the sensor MA95A/96A
0, 1	-30 to -60 dBm ranges To turn on relay K2 in the sensor MA95A/96A
1, 1	-60 to -90 dBm ranges To turn off relay K1, K2 in the sensor MA95A/96A
RS3 RS2 RS1	To be used for range select of the amplifier for low level.
1, 0, 1	0 dBm range ATT1 = 40 dB, ATT2 = 40 dB
0, 1, 1	-10 " ATT1 = 40 dB, ATT2 = 20 dB
0, 0, 1	-20 " ATT1 = 40 dB, ATT2 = 0 dB
1, 0, 1	-30 " ATT1 = 40 dB, ATT2 = 40 dB
0, 1, 1	-40 " ATT1 = 40 dB, ATT2 = 20 dB
0, 0, 1	-50 " ATT1 = 40 dB, ATT2 = 0 dB
1, 0, 0	-60 " ATT1 = 0 dB, ATT2 = 40 dB
0, 1, 0	-70 " ATT1 = 0 dB, ATT2 = 20 dB
0, 0, 0	-80 " ATT1 = 0 dB, ATT2 = 0 dB
RC RB RA	To be used for range select of the amplifier for high level.
0 0 0	+10 dB range Relay K1 in I/V circuit: ON
0 0 1	0 dB " " K2 " "
0 1 0	-10 dB " " K3 " "
0 1 1	-20 dB " " K4 " "
1 0 0	-30 dB " " K5 " "
1 0 1	-40 dB " " K6 " "
1 1 0	-50 dB " " K7 " "
1 1 1	-60 dB " " K1 K6 " : OFF
A/D REF	Reference voltage select of A/D
0	A/D input 1.2 to 0.25 V
1	A/D input 0.1 to 0.5 V

Table 7-1 Explanation of Control Signals (Cont'd)

Name and Value of Signal *	Description
TO	Auxiliary signal for range select when the MA95A/96A I/V circuit becomes saturaged and no AC signal is provided.
0	MA95A/96A input value proper
1	MA95A/96A input value excessive

Regarding optical power sensor changes

Name and Value of Signal *	Description
DS2, DS1	Sensor identification signal
0, 0	MA95A
1, 1	MA96A
0, 1	MA97A
1, 0	MA98A
FUNC 1	ZERO SET LOOP sensitivity changeover of the MA97A/98A
0	MA97A
1	MA98A
FUNC 2	Power source changeover and input changeover when the M95A/96A or the MA97A/98A is connected.
0	Power source ±12V(A), ±12V(C) ON when the MA95A/96A is connected.
1	Power source ±12V(B) ON when the MA97A/98A is connected.
+12V(A)	To turn on and off power source +12V(A) for circuit changeover at FUNC 2 and connect the input signal to amplifier high level or low level.
+12V	MA95A/96A
0V	MA97A/98A

Table 7-1 Explanation of Control Signals (Cont'd)

Filter Circuit Changeover

Name and Value of Signal *	Description
RESB, RESA	To changeover response according to the range.
0, 0	Response 20 sec
0, 1	" 2 sec
1, 0	" 0.2 sec

Others

Name and Value of Signal *	Description
BLANK	To output ground signal from BLANKING OUTPUT during ZERO SET.
0	Other than FINE ZERO SET period
1	FINE ZERO SET period

* { 1: ≧1.5 V
  { 0: ≦0.5 V

7.2.2 Control Circuit P.C. Board Troubleshooting Flowchart

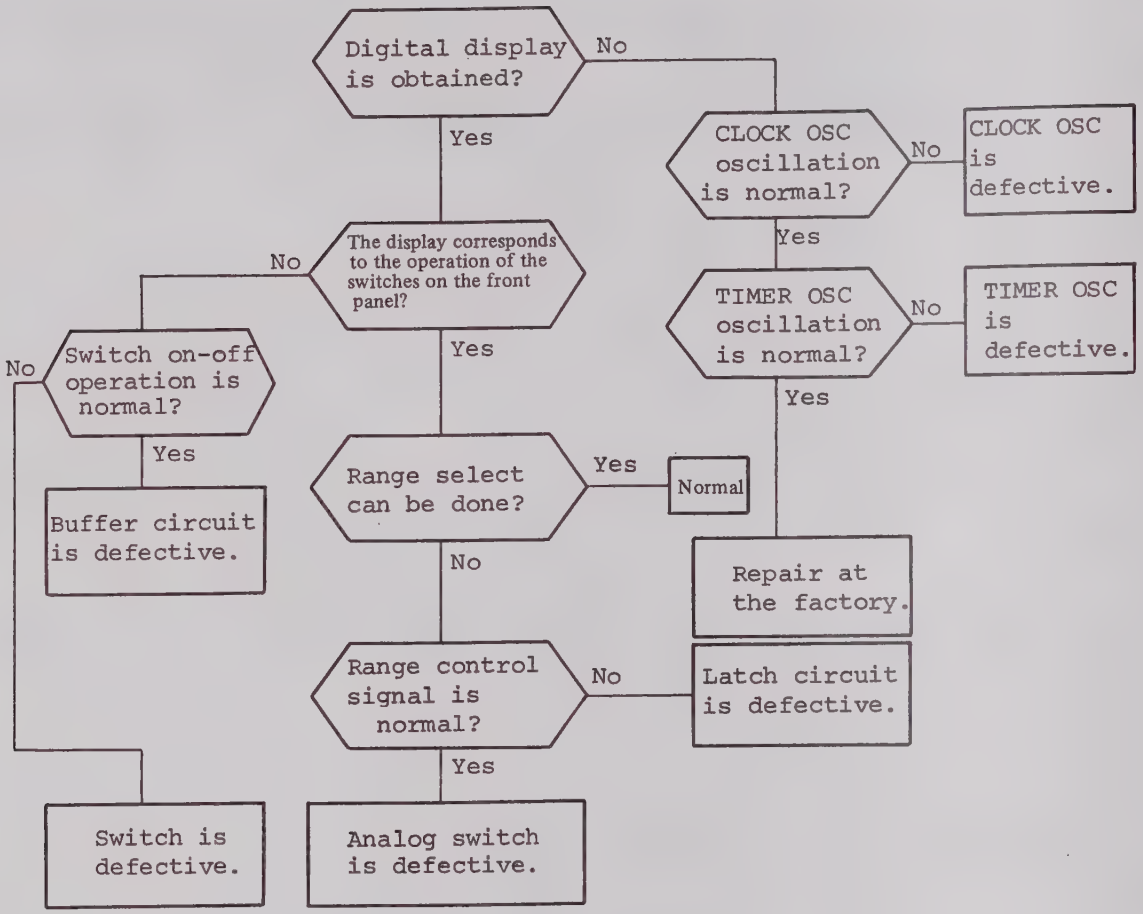
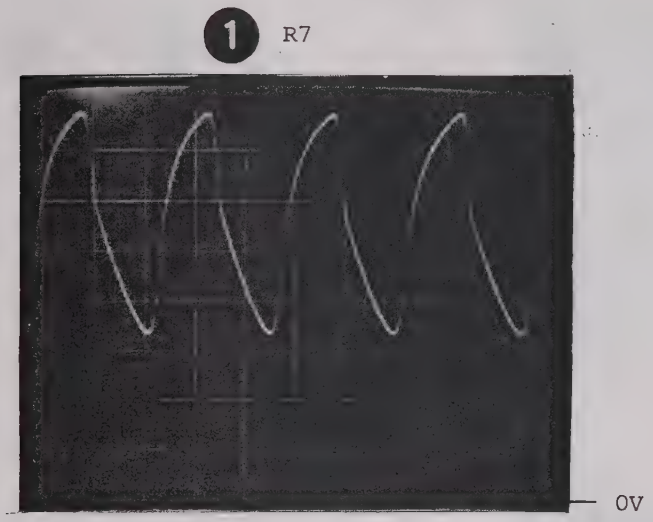


Fig. 7-4 Control Circuit P.C. Board Troubleshooting

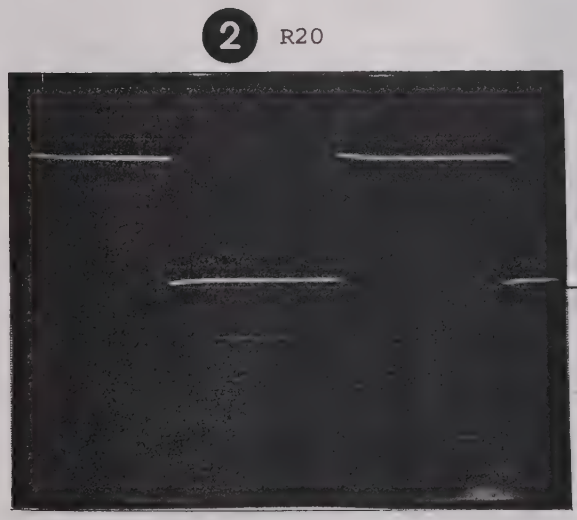
7.2.3 Control Circuit P.C. Board Test Point Waveforms and Component Arrangement Diagrams



A/D OSC OUT

Ⓥ : 1 V/div

Ⓗ : 1 μsec/div

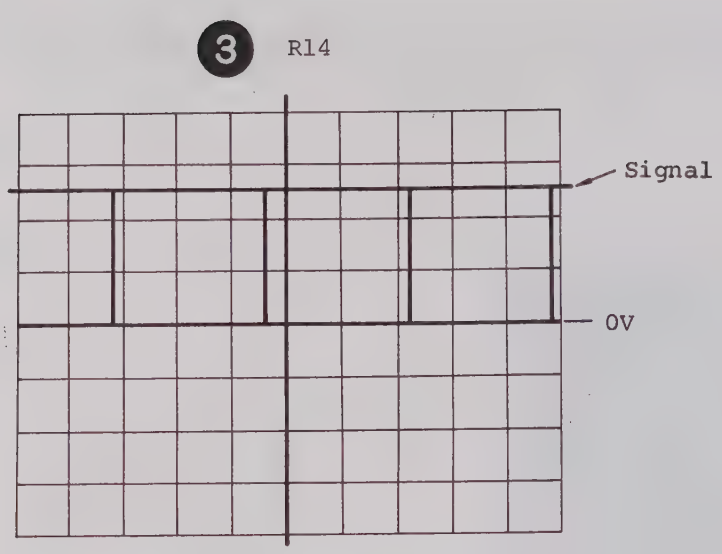


TIMER INT CLOCK

Ⓥ : 2 V/div

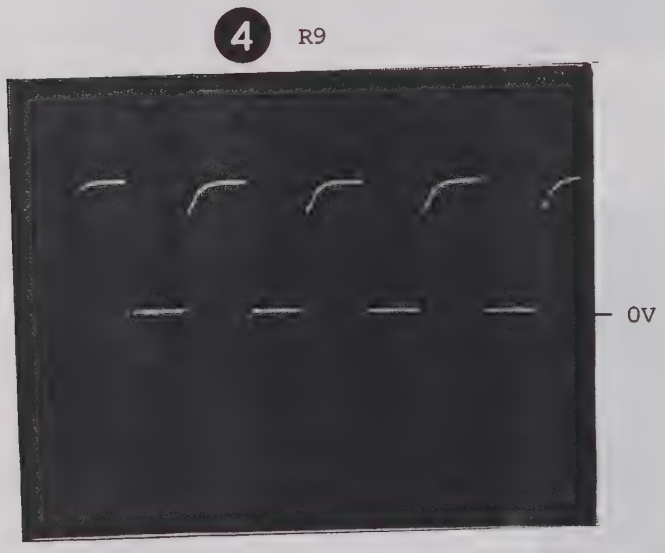
Ⓗ : 0.2 msec/div

Fig. 7-5 Control Circuit P.C. Board Test Point Waveforms



CPU $\overline{INT}$

Ⓥ : 2 V/div
Ⓗ : 0.5 msec/div



CLK

Ⓥ : 2 V/div
Ⓗ : 0.2 µsec/div

The above test points positions are shown in Fig. 7-6.

Fig. 7-5 (Continued)

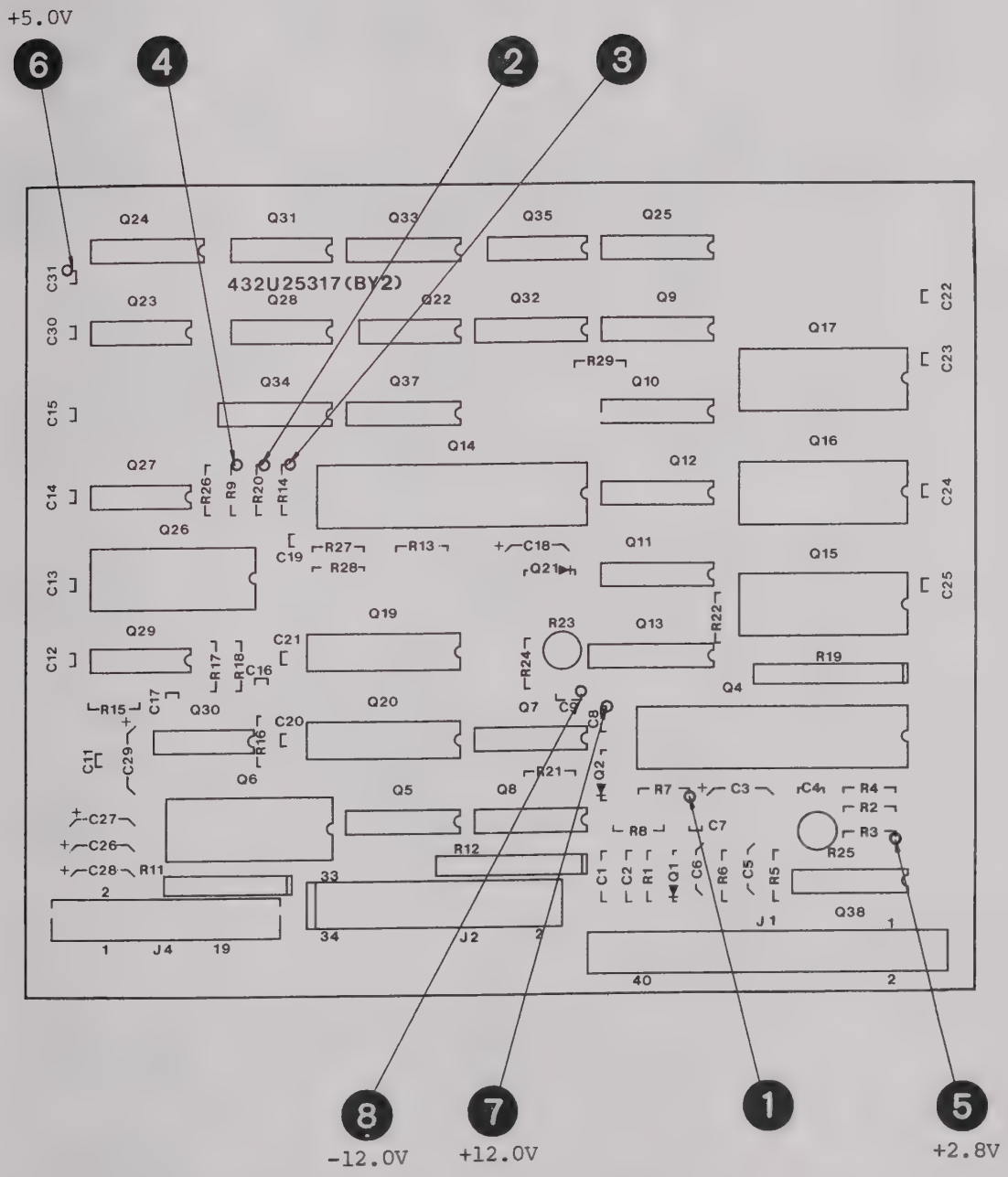


Fig. 7-6 Control Circuit P.C. Board Component Arrangement Diagram

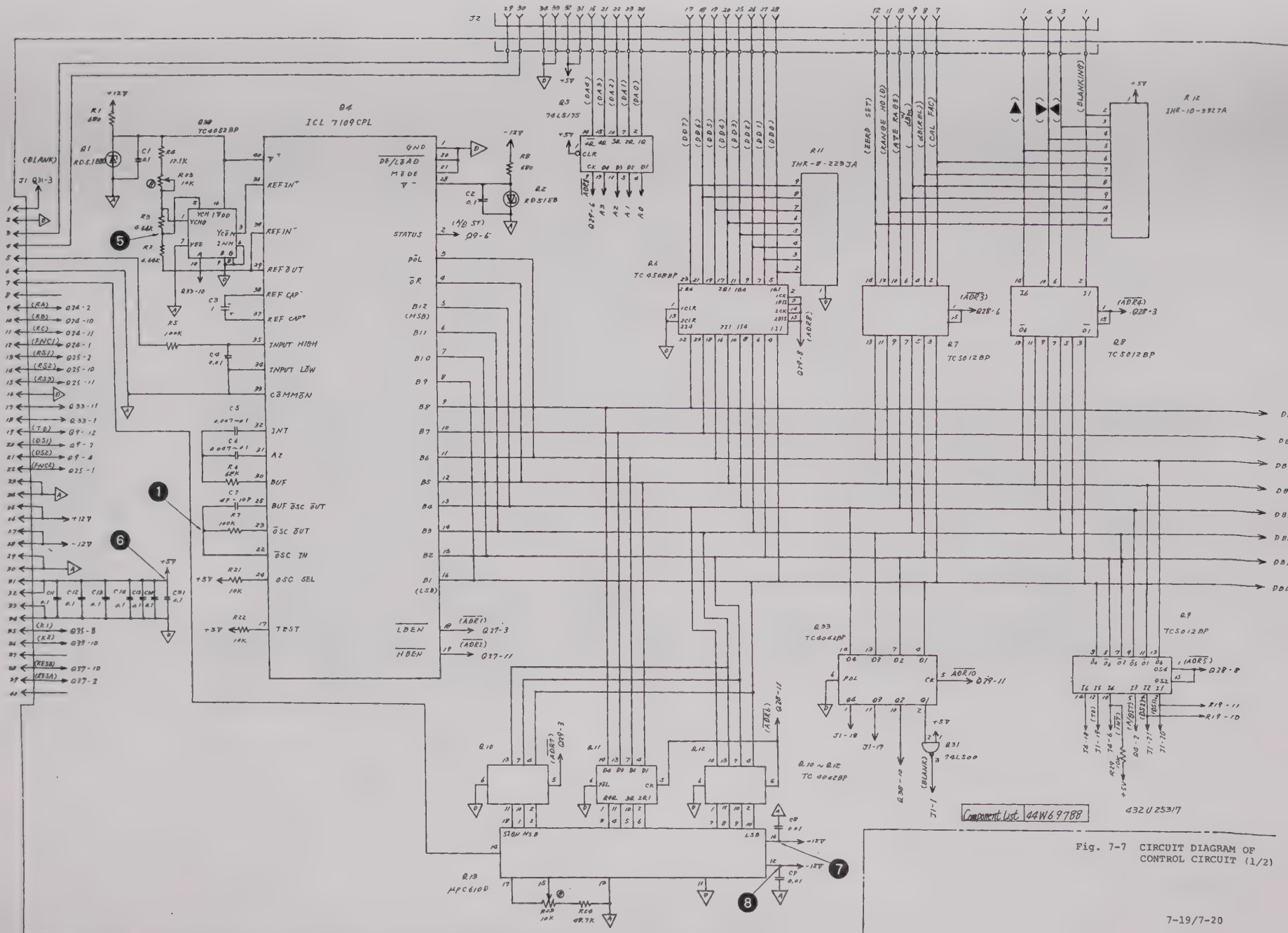


Fig. 7-7 CIRCUIT DIAGRAM OF CONTROL CIRCUIT (1/2)

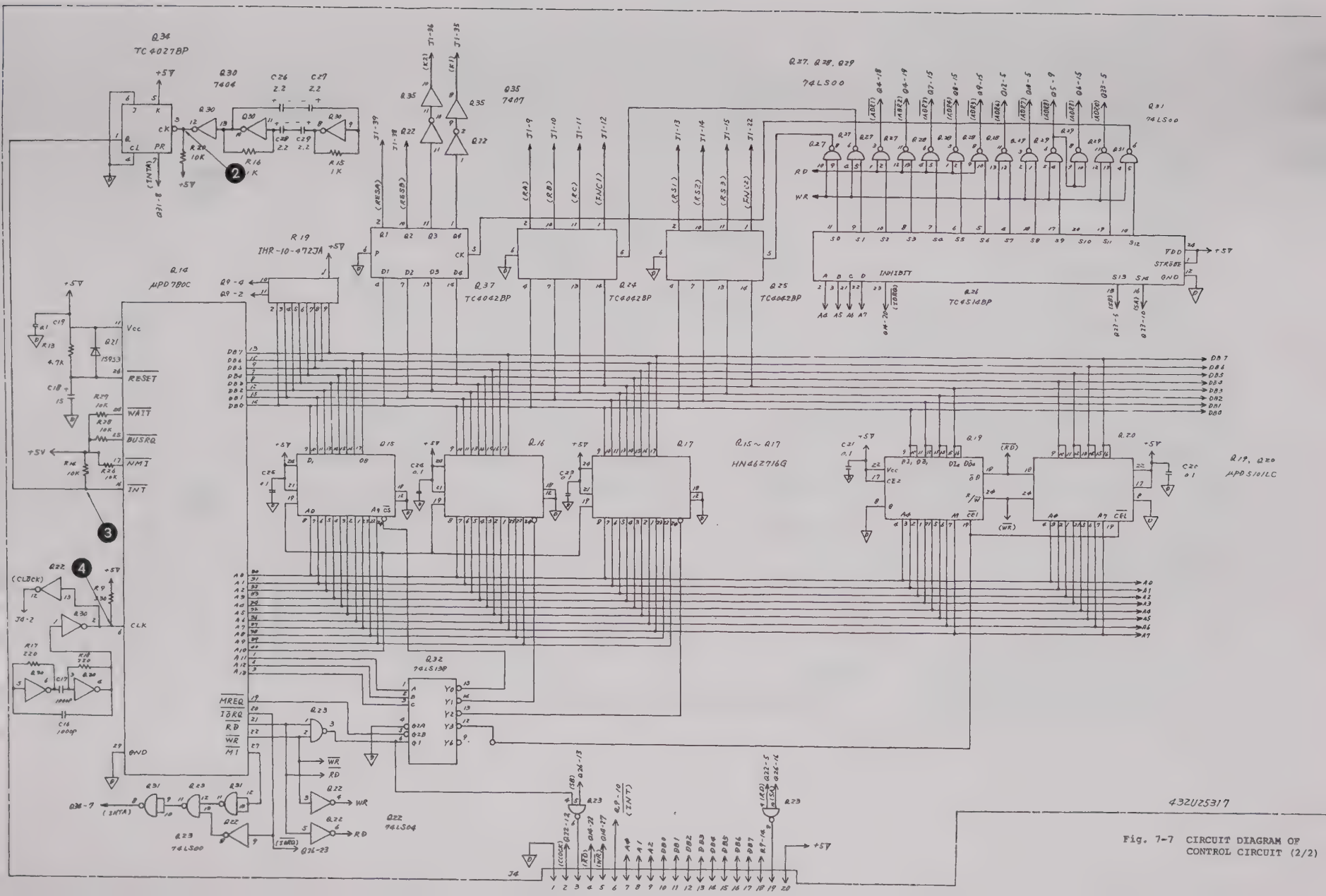


Fig. 7-7 CIRCUIT DIAGRAM OF CONTROL CIRCUIT (2/2)

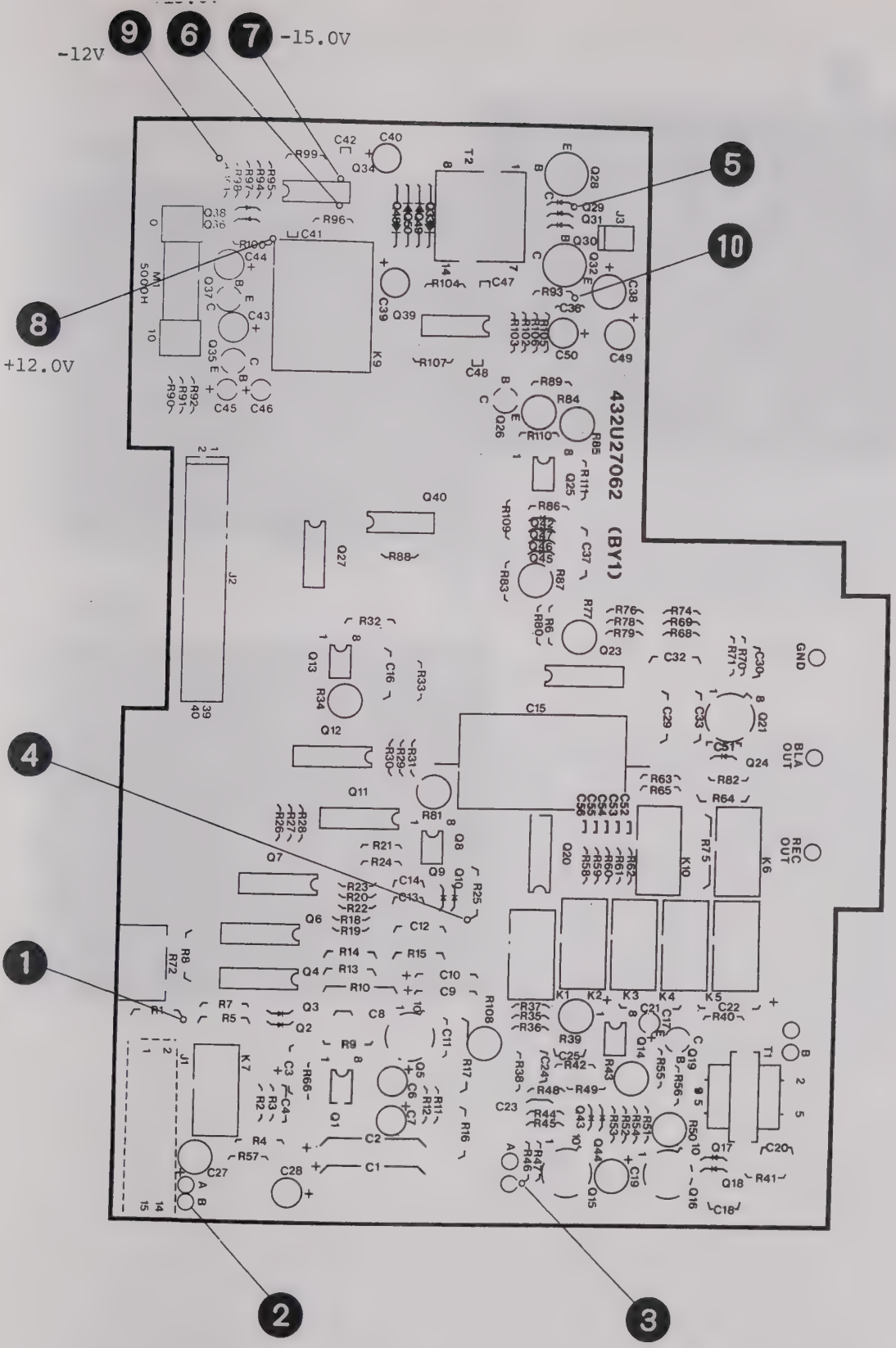
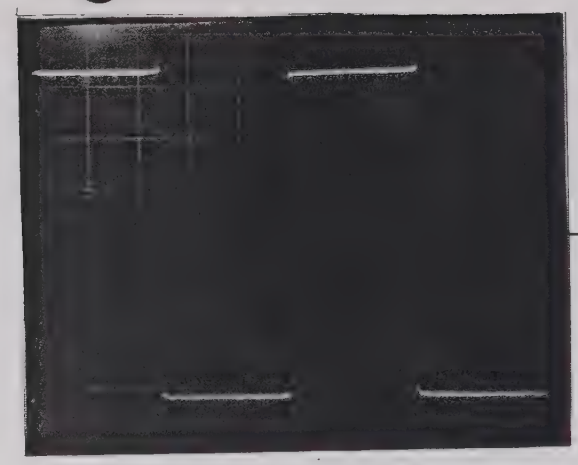


Fig. 7-9 Power Source, Amplifier P.C. Board Component Arrangement Diagram

5 Q29

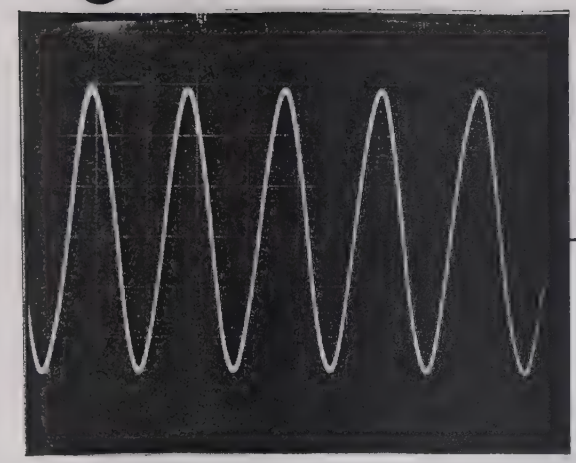


Ⓥ : 5 V div
Ⓗ : 2 msec/div

The above test points positions are shown in Fig. 7-9.

Fig. 7-8 (Continued)

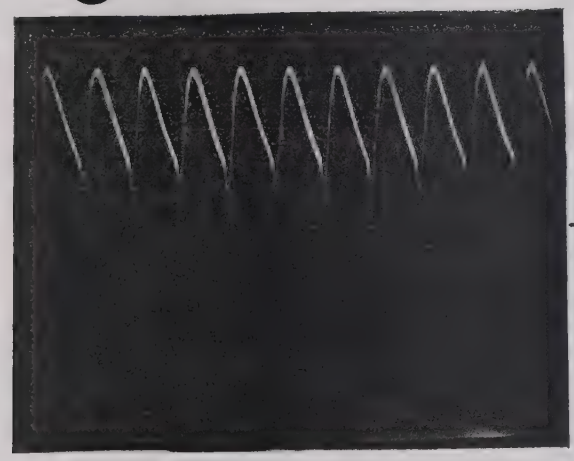
3 R46



0v

Ⓥ : 0.2 V/div
Ⓗ : 2 msec/div

4 R25

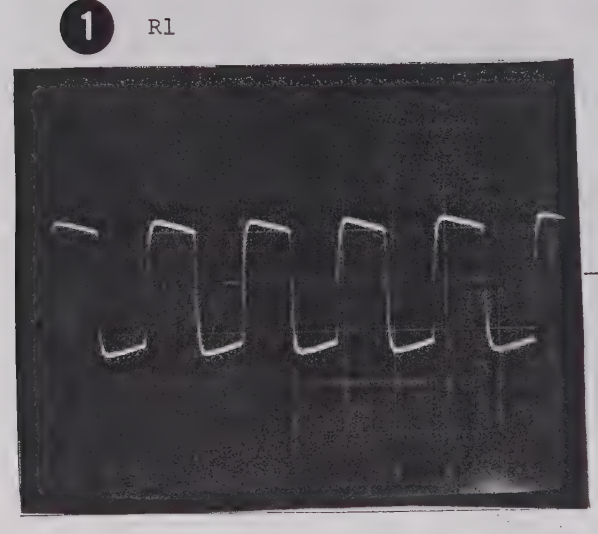


0v

Optical power input: -30 dBm

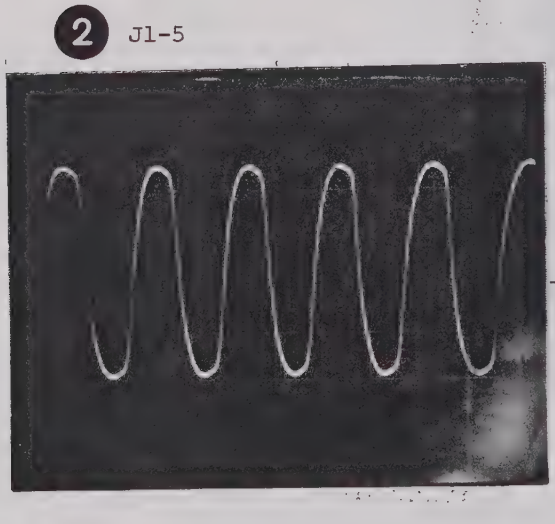
Ⓥ : 0.2 V/div
Ⓗ : 2 msec/div

Fig. 7-8 (Continued)



Optical power input: -30.0 dBm

Ⓥ : 0.5 V/div
Ⓗ : 2 msec/div



Ⓥ : 10 V/div
Ⓗ : 2 msec/div

Fig. 7-8 Power Source, Amplifier P.C. Board
Test Point Waveforms

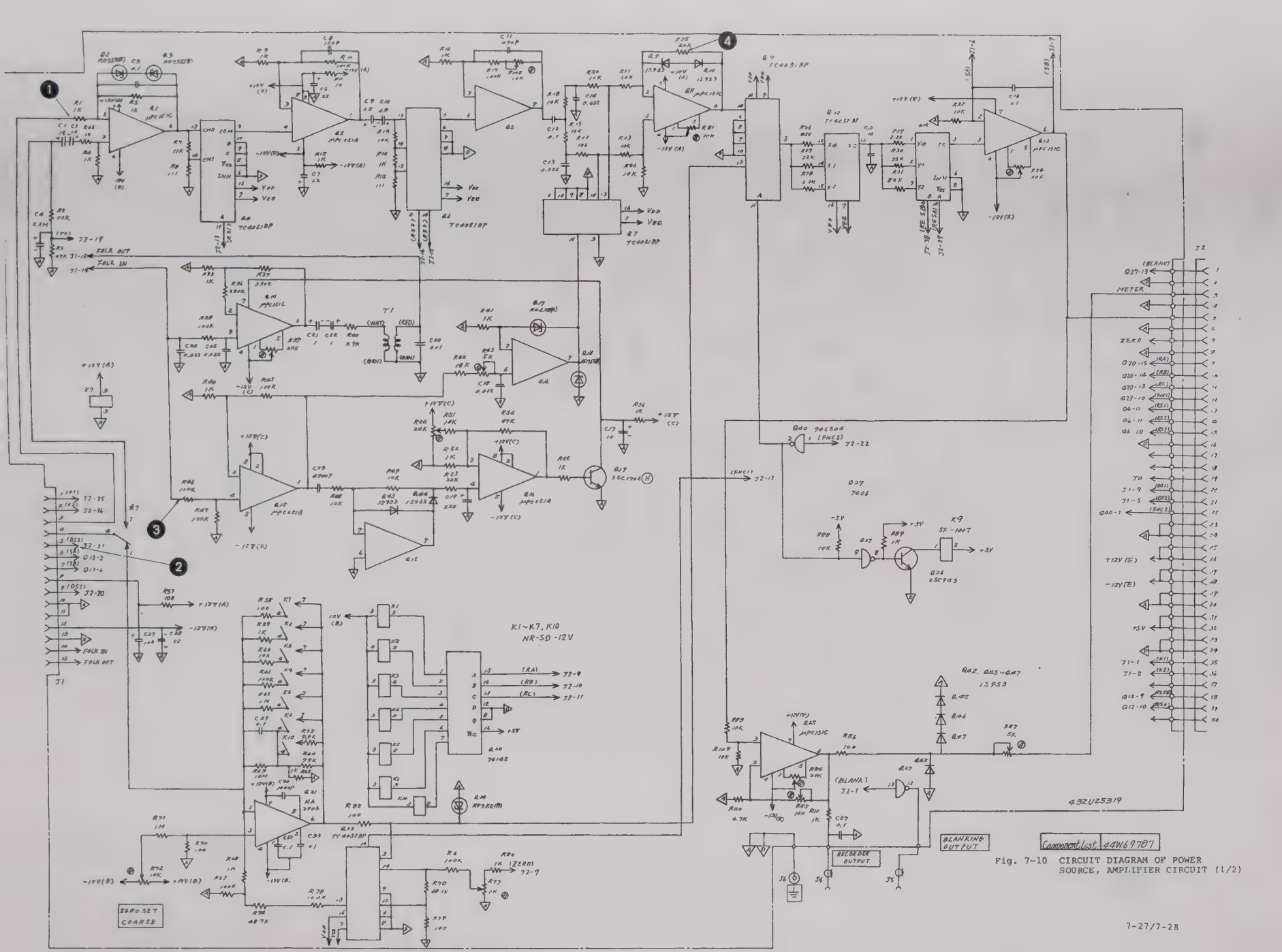


Fig. 7-10 CIRCUIT DIAGRAM OF POWER SOURCE, AMPLIFIER CIRCUIT (1/2)

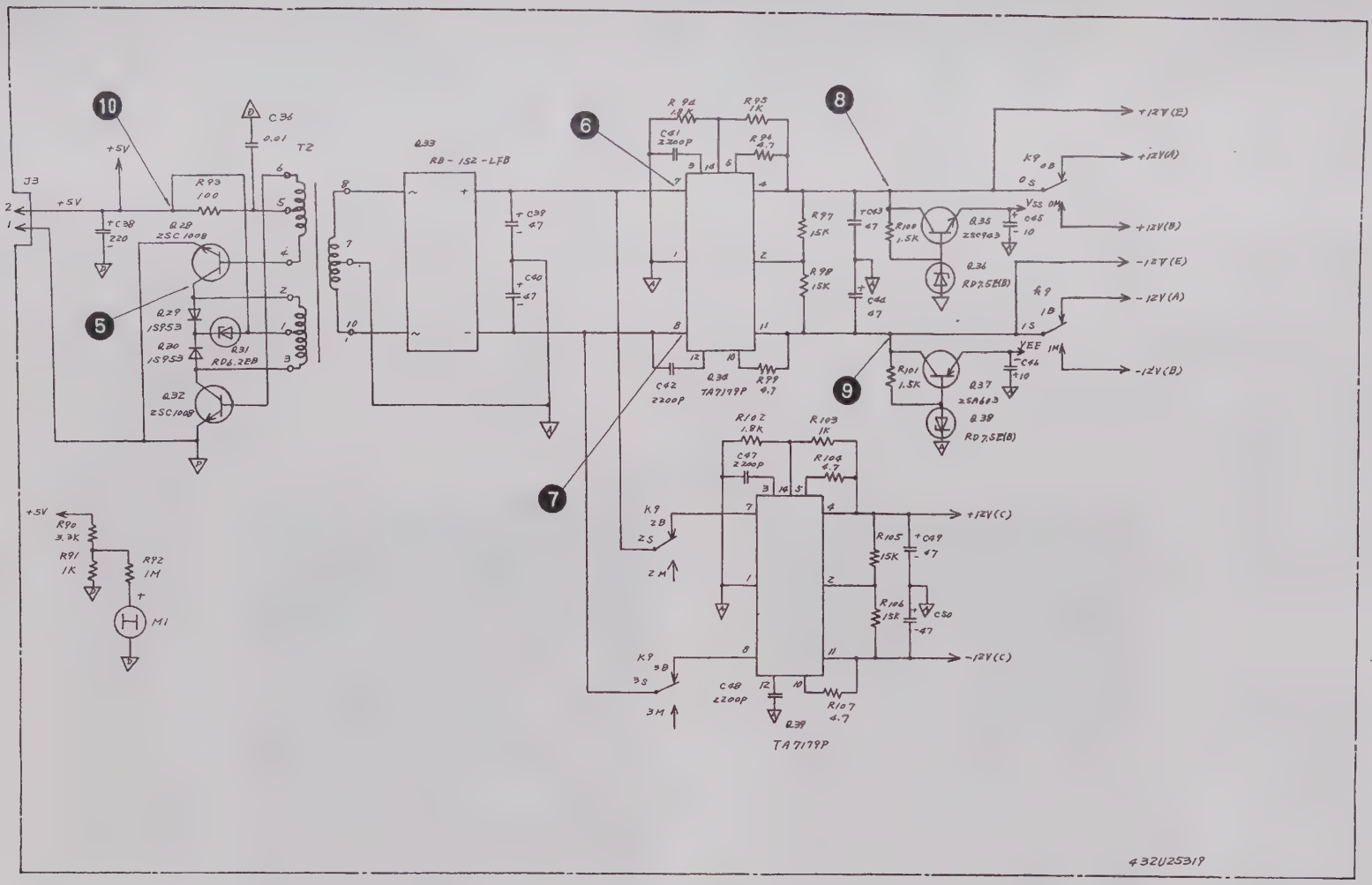
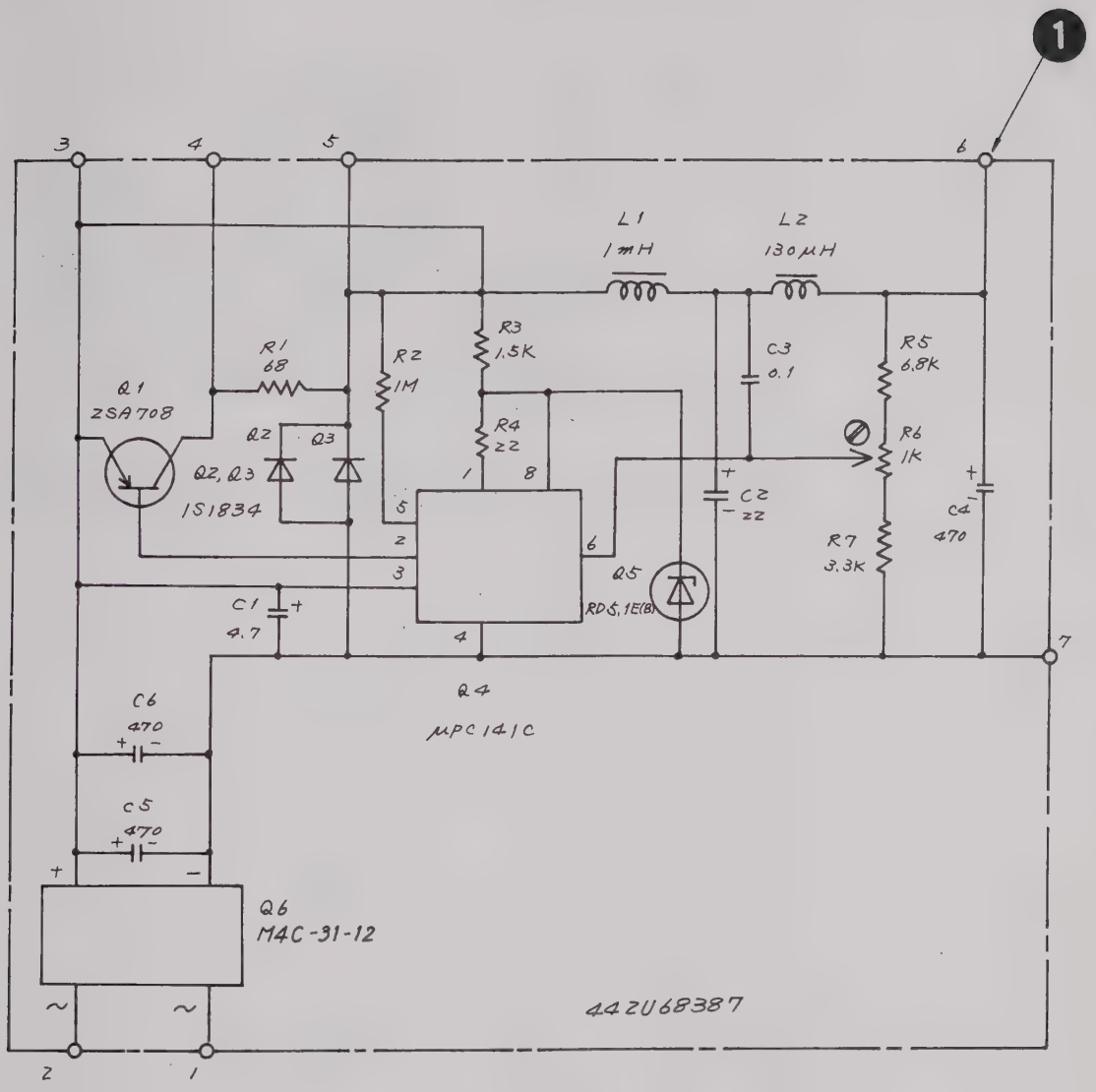


Fig. 7-10 CIRCUIT DIAGRAM OF POWER SOURCE, AMPLIFIER CIRCUIT (2/2)



Component list	44W69790

Fig. 7-12 CIRCUIT DIAGRAM OF
5V POWER SOURCE

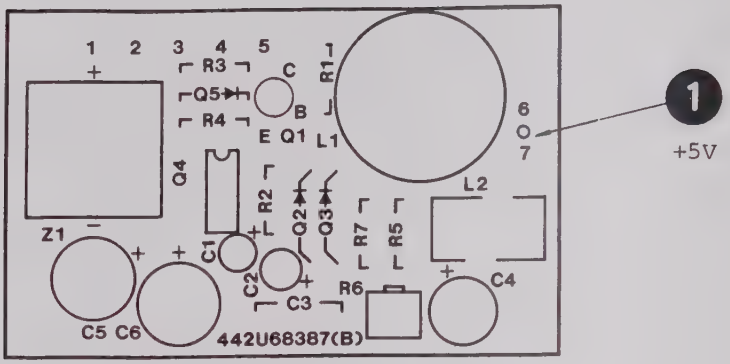
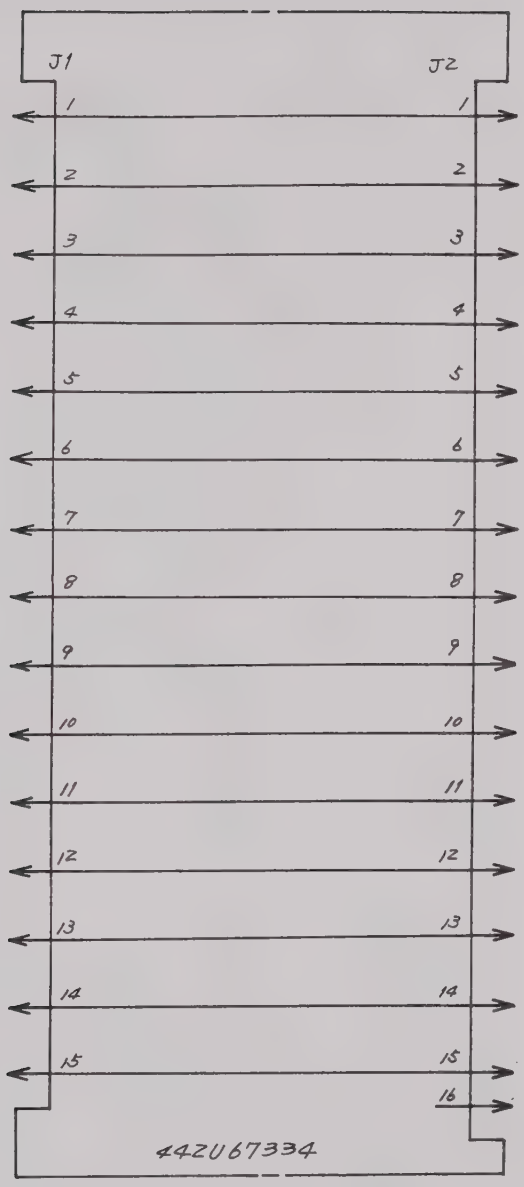


Fig. 7-11 +5 V Power Source P.C. Board
Component Arrangement Diagram



Component List	44W69785

Fig. 7-13 CIRCUIT DIAGRAM OF CONNECTOR P.C. BOARD

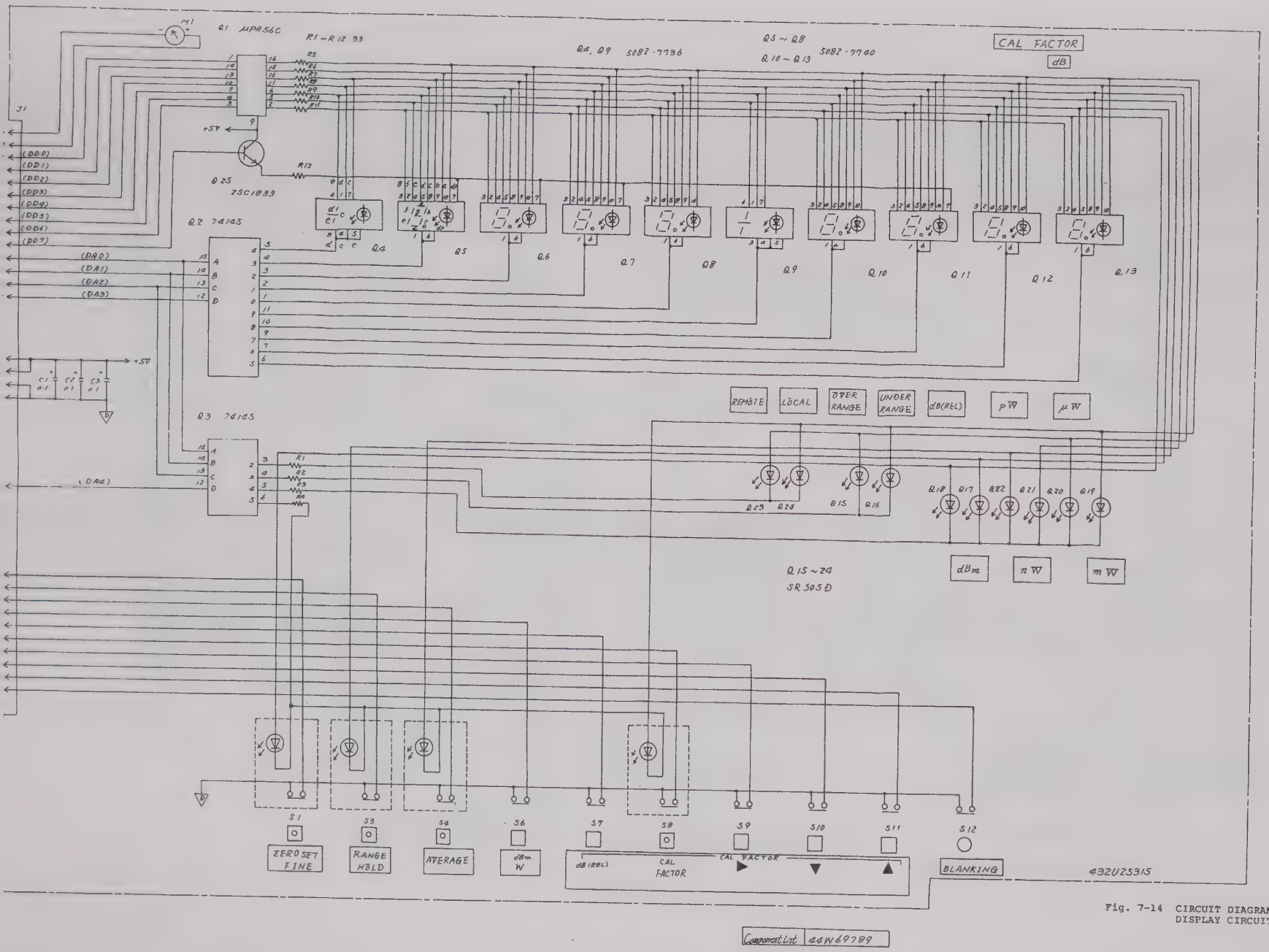
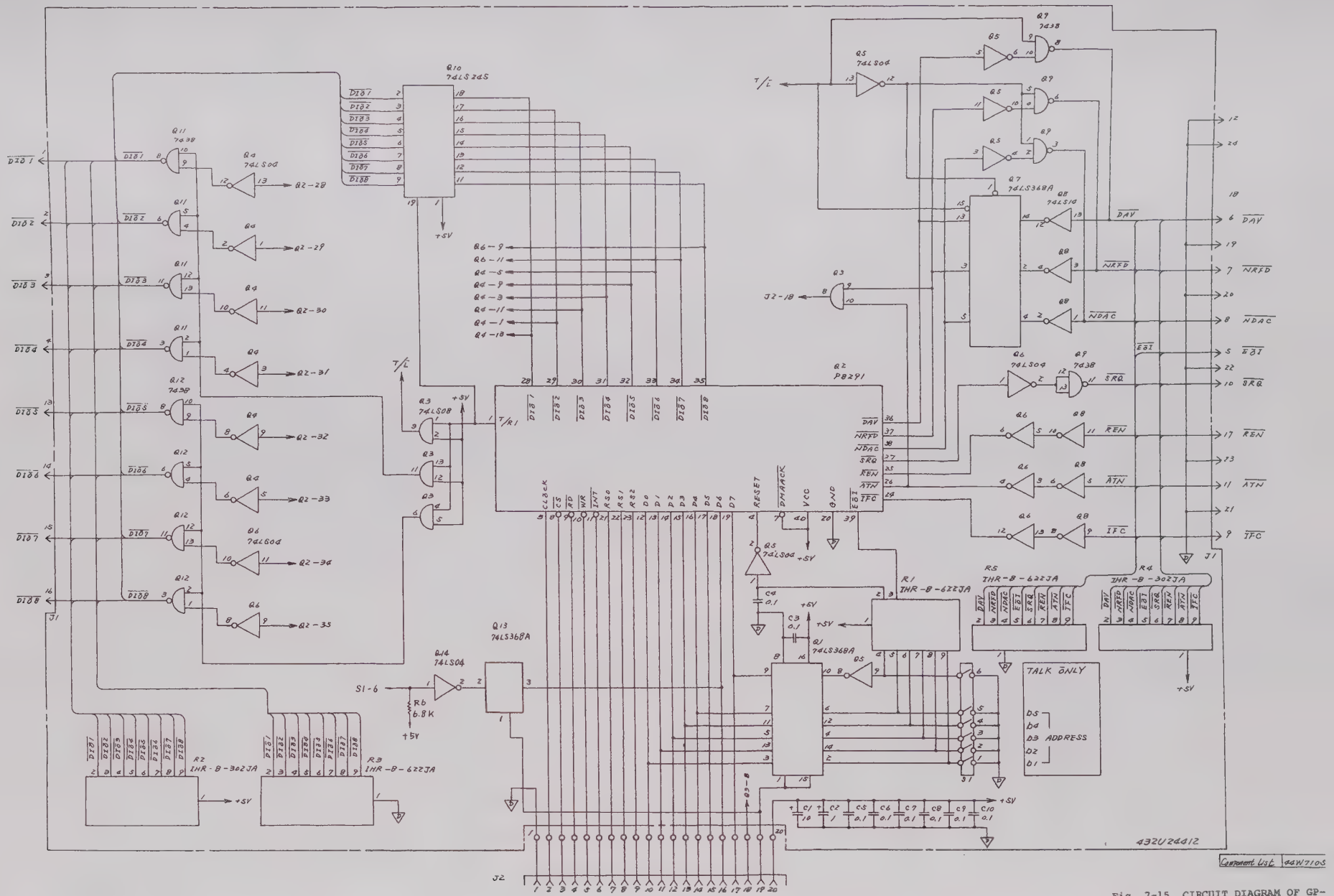


Fig. 7-14 CIRCUIT DIAGRAM OF DISPLAY CIRCUIT

Component List 44W69789



Component List 44W7105

Fig. 7-15 CIRCUIT DIAGRAM OF GP-IB (OPTION)

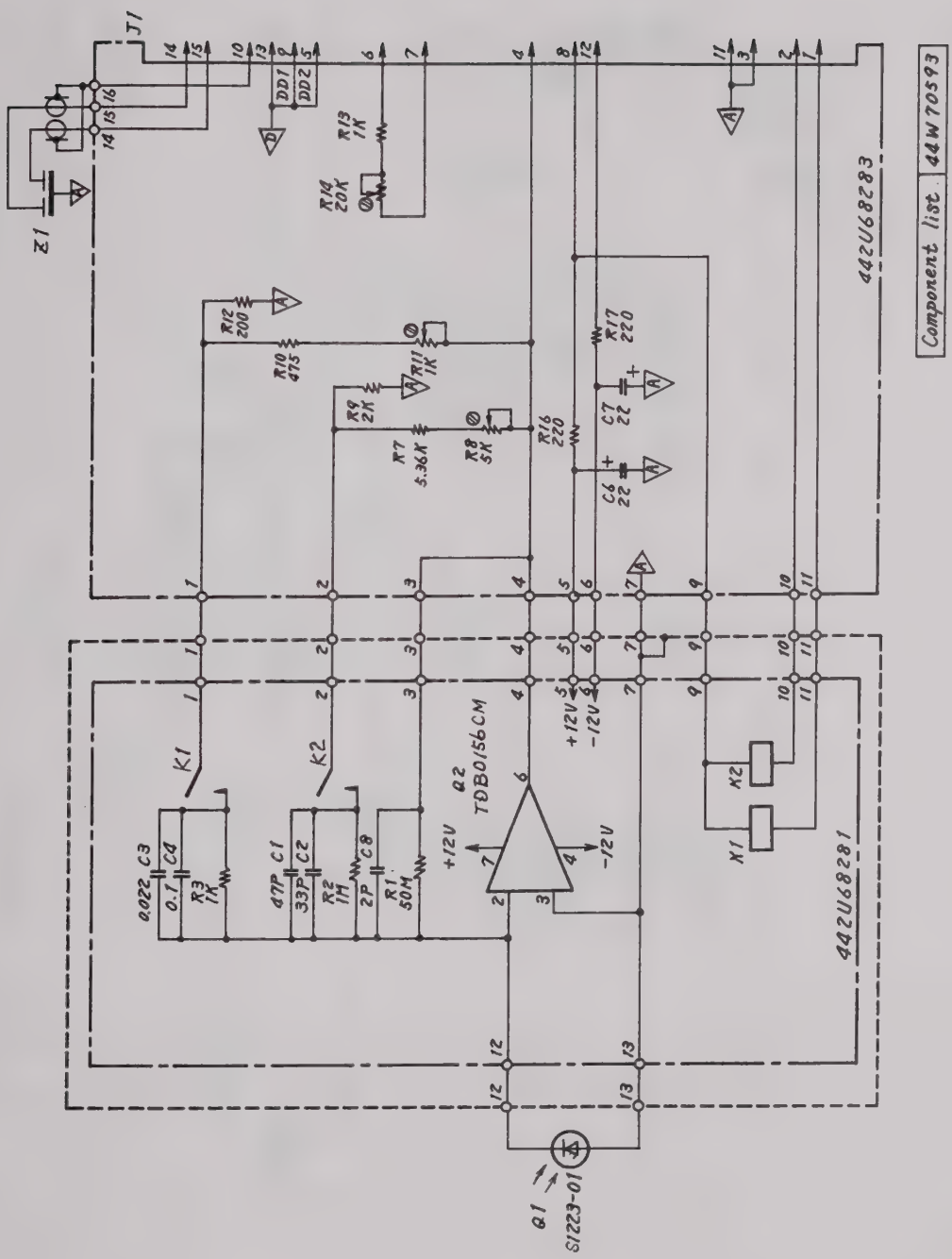


Fig. 7-16 CIRCUIT DIAGRAM OF OPTICAL SENSOR MA95A

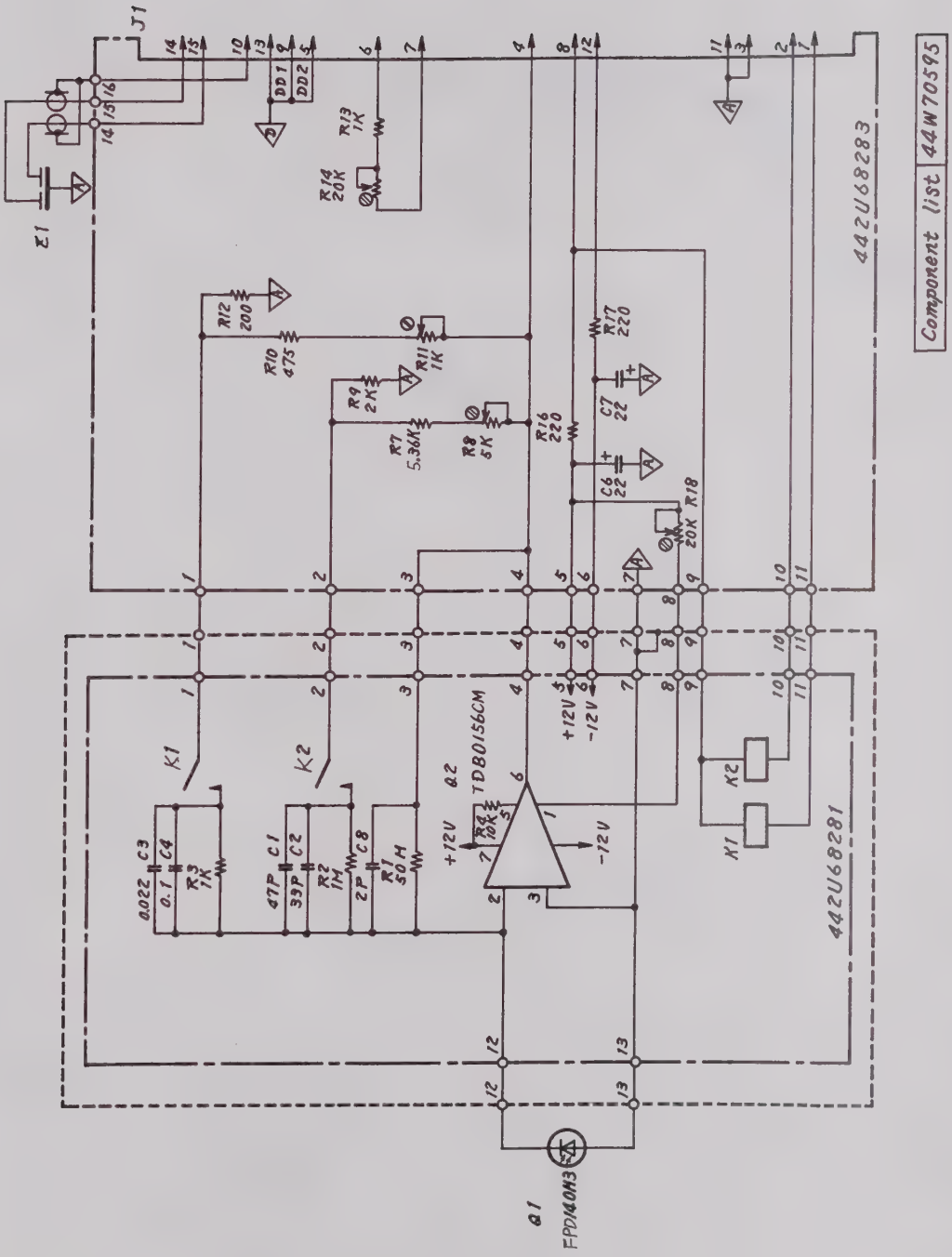


Fig. 7-17 CIRCUIT DIAGRAM OF OPTICAL SENSOR MA96A

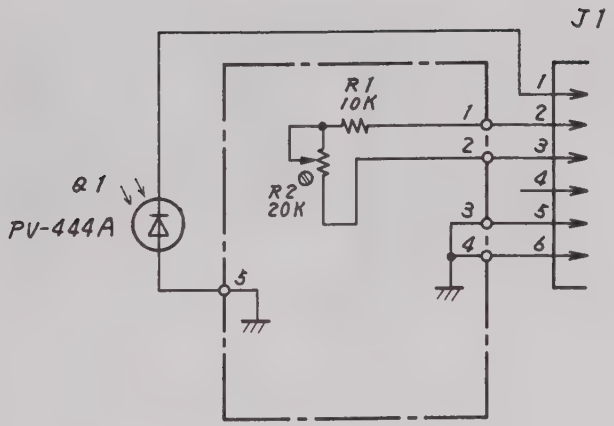


Fig. 7-18 CIRCUIT DIAGRAM OF
OPTICAL SENSOR MA97A

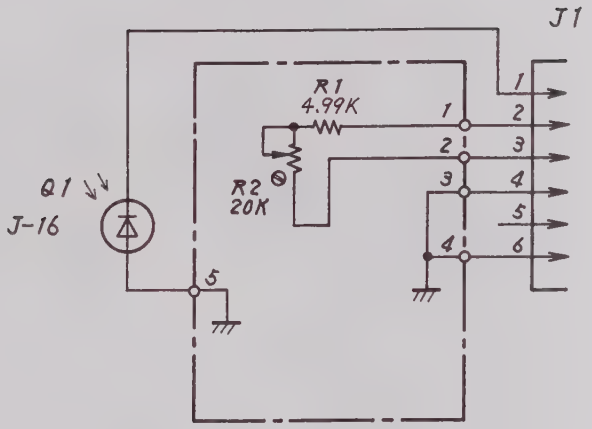


Fig. 7-19 CIRCUIT DIAGRAM OF
OPTICAL SENSOR MA98A

SECTION 8

REPLACEABLE PARTS

8.1 Introduction

This section contains information relative to ordering replacement components. The following table shows circuit reference (hereinafter CKT REF) and abbreviations used for components given in the component list. In the component list, the quantity of each component is one so far as no quantitative description is given in the "NOTE" column.

(1) Circuit reference

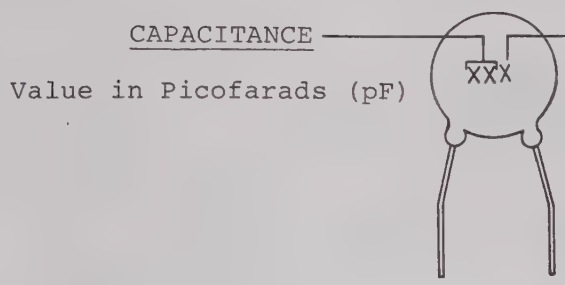
AT: Attenuator	K: Relay	Q: Transistor, Diode, Rectifier, IC	T: Transformer
C: Capacitor	L: Coil	R: Resistor	V: Neon lamp, Vaccumtube
F: Fuse	M: Meter, timer	S: Switch	Z: Unit
J: Jack, plug, connector	P: Lamp		

(2) Abbreviations

A	: amperes	J-FET	: junction FET	PNP	: positive-negative-positive
Att, R var	: attenuator variable using film resistive elements	k	: kilo ($\times 10^3$)	p-p, pp	: peak to peak value
BL	: boundary layer	LED	: light emitting diode	RFC	: RF choke
				R-lamp	: resistor lamp
Cer	: ceramic	M	: mega ($\times 10^6$)	rms	: effective value (root means square)
CF	: carbon film	m	: milli ($\times 10^{-3}$)		
Comp	: composition	MF	: metallized film	SBD	: shottky barrier diode
CRT	: cathode-ray tube	MOS-FET	: metal oxide semi-conductor FET	SCR	: sillicon controlled rectifier
		M paper	: metallized paper	Si	: sillicon
Di	: diode	M plast	: metallized plastic film	SRD	: step recovery diode
DIL type	: dual-in line type	Multi	: multiplying		
				Tant	: tantalum
Elect	: electrolyte aluminum	N ch	: N channel	Tr	: transistor
		non-lin	: non-linear taper	Trans	: transformer
F	: farad	Non-pol	: non-polarity		
FET	: field effect transistor	NPN	: negative-positive-negative	μ	: micro ($\times 10^{-6}$)
G	: ground			V	: volt
Ge	: germanium	Ω	: ohms	Var	: variable
H	: henry				
Hz	: hertz	p	: pico ($\times 10^{-12}$)	WW	: wire wound
		Plast	: plastic film		
IC	: integrated circuit	PMTR	: potentiometer	XTAL	: crystal
IEC	: Applicable to IEC Safety Standard				

8.2 METHOD OF READING CAPACITORS/RESISTORS

8.2.1 Capacitor Identification

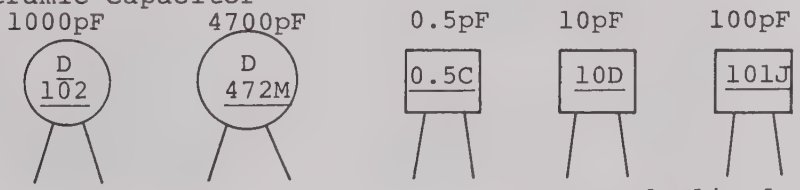


EXAMPLES: 103 = 10,000pF = 10^{-8}F or 0.01μF
302 = 3,000pF = $3x10^{-9}$F or 0.003μF
676 = 67,000,000pF = $67x10^{-6}$F or 67μF

(a) Ceramic capacitor, polyester capacitor

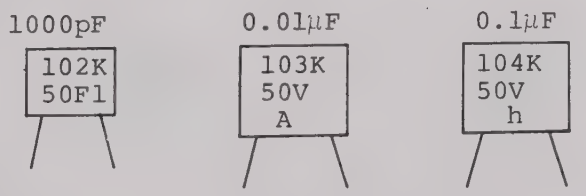
Indication	0.5	1	10	101	102	103	104
Capacity	0.5pF	1pF	10pF	100pF	1000pF	0.01μF	0.1μF

Example:
Ceramic Capacitor



Capacity values are always underlined.

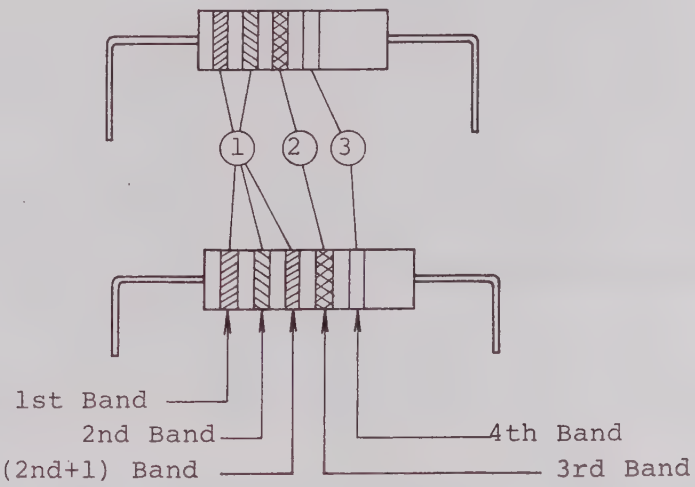
Polyester Capacitor



(b) Tantalum capacitor. Metallized capacitor and Electrolytic capacitor

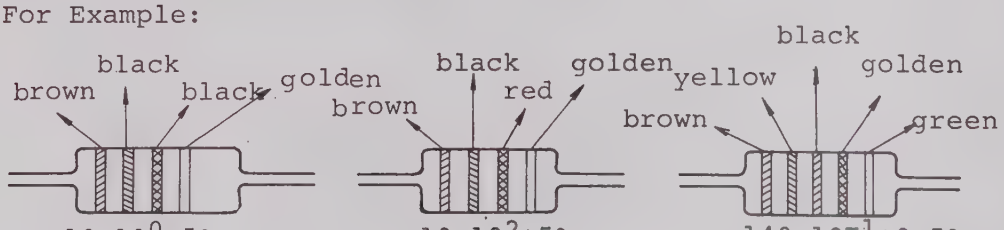
Indication	OR47	010	100	101
Capacity	0.47μF	1μF	10μF	100μF

8.2.2 Resistor Identification



	①		②	③
COLOR	Figure		Multiplier	Tolerance
	1st	2nd	3rd	4th
Black	0	0	$x10^0$	-
Brown	1	1	$x10^1$	-
Red	2	2	$x10^2$	-
Orange	3	3	$x10^3$	-
Yellow	4	4	$x10^4$	-
Green	5	5	$x10^5$	±0.5%
Blue	6	6	$x10^6$	-
Purple	7	7	$x10^7$	-
Grey	8	8	$x10^8$	-
White	9	9	$x10^9$	-
Gold	-	-	$x10^{-1}$	±5%
Silver	-	-	$x10^{-2}$	±10%
-----	-	-		±20%

For Example:



$10x10^0±5\%$ $10\Omega,±5\%$

$10x10^2±5\%$ $1k\Omega,±5\%$

$140x10^{-1}±0.5\%$ $14.0\Omega,±0.5\%$

8.3 Ordering Information

Upon ordering components, please give the following descriptions by referring to the C.L. (Component List).

Item	Example
(1) Name of instrument	Optical Power Meter ML93A
(2) Name of component	Component List of Control Circuit
(3) CKT REF	C16
(4) Name of component	CK45D1H 102MY Note: Part name is given in parentheses ( ) in the C.L. (Component List). Components with asterisks* are those that require factory adjustment upon repairing. When ordering a component or components with asterisk, give full description of the component.
(5) Quantity	1
(6) Serial No. of instrument	Serial No. M31257

8.4 Component List

COMPONENT LIST OF OPTICAL POWER METER ML93A

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Elect,(CE62W1V472)	4700μF,+100/-10%,35V		
F 1	Fuse, (MF51NN250V * AAC05)	* A		
F 2	Fuse, (MF51NN250V2AAC05)	2A		
J 1	Housing, connector, (PI011-2F)			
J 2	Receptacle,(P-1306-DB)			
J 3	Power supply cord with plug			
Q 1	Tr,Si,NPN,(2SD297)			
S 1	Lever,(8M4021)			
T 1	Trans,(44T65701)	26VA		
Z 1	442U67334P.C.Board CONNECTOR BOARD			44W69785
Z 2	432U25319P.C.Board POWER SOURCE, AMPLIFIER SECTION			44W69787
Z 3	432U25317P.C.Board CONTROL CIRCUIT			44W69788
Z 4	432U25315P.C.Board DISPLAY CIRCUIT			44W69789
Z 5	432U24412P.C.Board IEC-IB			OPTION
Z 6	Noise filter, (ZGB2202-01)			
Z 7	442U68387P.C.Board 5V POWER SOURCE			44W69790

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF CONNECTOR BOARD

CKT REF	DESCRIPTION	RATING		NOTE
J 1	Connector,(U-PA1521)			
J 2	Connector, (R15A-17R-16PB)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF POWER SOURCE, AMPLIFIER SECTION

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Tant,(CS02H1V100M)	10μF,±20%,35V		
C 2	Tant,(CS02H1V100M)	10μF,±20%,35V		
C 3	Plast,(ECQ-M1H 104KZ)	0.1μF,±10%,50V		
C 4	Tant,(CS02H1D2R2M)	2.2μF,±20%,20V		
C 5	Not assigned			
C 6	Elect,(CE04W1V220)	22μF,+100/-10%,35V		
C 7	Elect,(CE04W1V220)	22μF,+100/-10%,35V		
C 8	Cer,(RD312CH151JY50)	150pF,±5%,50V		
C 9	Tant,(CS02H0J6R8M)	6.8μF,±20%,6.3V		
C 10	Tant,(CS02H0J6R8M)	6.8μF,±20%,6.3V		
C 11	Cer,(RD314CH471JY50)	470pF,±5%,50V		
C 12	Plast,(ECQ-M1H 104KZ)	0.1μF,±10%,50V		
C 13	Plast,(ECQ-M1H223KZ)	0.022μF,±10%,50V		
C 14	Plast,(ECQ-M1H223KZ)	0.022μF,±10%,50V		
C 15	Tant,(432A1003 106K)	10μF,±10%,100V		
C 16	Plast,(ECQ-M1H 104KZ)	0.1μF,±10%,50V		
C 17	Elect,(CE04W1V100)	10μF,+100/-10%,35V		
C 18	Plast,(ECQ-M1H 223KZ)	0.022μF,±10%,50V		
C 19	Elect,(CE04W1A221)	220μF,+100/-10%,10V		
C 20	Plast,(ECQ-M1H 103KZ)	0.01μF,±10%,50V		
C 21	Tant,(CS02H1V010M)	1μF,±20%,35V		
C 22	Tant,(CS02H1V010M)	1μF,±20%,35V		
C 23	Plast,(ECQ-M1H 472KZ)	4700pF,±100%,50V		
C 24	Plast,(ECQ-M1H 223KZ)	0.022μF,±10%,50V		
C 25	Plast,(ECQ-M1H 223KZ)	0.022μF,±10%,50V		
C 26	Not assigned			
C 27	Elect,(CE04W1E101)	100μF,+100/-10%,25V		
C 28	Elect,(CE04W1V220)	22μF,+100/-10%,35V		
C 29	Plast,(ECQ-M1H 104KZ)	0.1μF,±10%,50V		
C 30	Plast,(ECQ-M1H 102KZ)	1000pF,±10%,50V		
C 31	Not assigned			
C 32	Plast,(ECQ-M1H 104KZ)	0.1μF,±10%,50V		
C 33	Plast,(ECQ-M1H 104KZ)	0.1μF,±10%,50V		
C 34	Not assigned			
C 35	Not assigned			
C 36	Plast,(ECQ-M1H 103KZ)	0.01μF,±10%,50V		
C 37	Plast,(ECQ-M1H 104KZ)	0.1μF,±10%,50V		
C 38	Elect,(CE04W1A221)	220μF,+100/-10%,10V		
C 39	Elect,(CE04W1E470)	47μF,+100/-10%,25V		
C 40	Elect,(CE04W1E470)	47μF,+100/-10%,25V		
C 41	Cer,(CK45D1H222MY)	2200pF,±20%,50V		
C 42	Cer,(CK45D1H222MY)	2200pF,±20%,50V		
C 43	Elect,(CE04W1E470)	47μF,+100/-10%,25V		
C 44	Elect,(CE041E470)	47μF,+100/-10%,25V		
C 45	Elect,(CE04W1V100)	10μF,+100/-10%,35V		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF POWER SOURCE, AMPLIFIER SECTION

CKT REF	DESCRIPTION	RATING		NOTE
C 46	Elect,(CE04W1V100)	10μF,+100/-10%,35V		
C 47	Cer,(CK45D1H222MY)	2200pF,±20%,50V		
C 48	Cer,(CK45D1H222MY)	2200pF,±20%,50V		
C 49	Elect,(CE04W1E470)	47μF,+100/-10%,25V		
C 50	Elect,(CE04W1E470)	47μF,+100/-10%,25V		
C 51	Not assigned			
C 52	Not assigned			
C 53	Not assigned			
C 54	Cer,(CK924C1H473M)	0.047μF,±20%,50V		
C 55	Cer,(CK924C1H103M)	0.01μF,±20%,50V		
C 56	Not assigned			
J 1	Connector,(U-SA1501)			
J 2	Connector, (HIF23A-40D-AA,10S)			
J 3	Connector,(PI011-2M)			
J 4	Receptacle,(BNC-R101)			
J 5	Receptacle,(BNC-R101)			
J 6	Terminal with knob	10ø		
K 1	Reed relay,(NR-SD-12V)			
K 2	Reed relay,(NR-SD-12V)			
K 3	Reed relay,(NR-SD-12V)			
K 4	Reed relay,(NR-SD-12V)			
K 5	Reed relay,(NR-SD-12V)			
K 6	Reed relay,(NR-SD-12V)			
K 7	Reed relay,(NR-SD-12V)			
K 8	Not assigned			
K 9	Relay,(SF-100F)			
K 10	Reed relay,(NR-SD-12V)			
M 1	Timer,(TM-O)			
Q 1	IC,(μPC151C)			
Q 2	Di,breakdown,(RD7.5EB)	7.0 to 7.9V,400mW		
Q 3	Di,breakdown,(RD7.5EB)	7.0 to 7.9V,400mW		
Q 4	IC,(TC4051BP)			
Q 5	IC,(μPC251A)			
Q 6	IC,(TC4051BP)			
Q 7	IC,(TC4051BP)			
Q 8	IC,(μPC151C)			
Q 9	Di,Si,(1S953)			
Q 10	Di,Si,(1S953)			
Q 11	IC,(TC4051BP)			
Q 12	IC,(TC4052BP)			
Q 13	IC,(μPC151C)			
Q 14	IC,(μPC151C)			
Q 15	IC,(μPC251A)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF POWER SOURCE, AMPLIFIER SECTION

CKT REF	DESCRIPTION	RATING		NOTE
Q 16	IC,(μPC251A)			
Q 17	Di,breakdown,(RD6.2EB)	5.8 to 6.6V,400MW		
Q 18	Di,breakdown,(RD7.5EB)	7.0 to 7.9V,400mW		
Q 19	Tr,Si,NPN,(2SC1706Ⓗ)			
Q 20	IC,(74145)			
Q 21	IC,(HA2905)			
Q 22	Not assigned			
Q 23	IC,(RC4052BP)			
Q 24	Di,breakdown,(RD7-5EB)	7.0 to 7.9V,400mW		
Q 25	IC,(μPC151C)			
Q 26	Tr,Si,NPN,(2SC943)			
Q 27	IC,(7406)			
Q 28	Tr,Si,NPN,(2SC1008)			
Q 29	Di,Si,(1S953)			
Q 30	Di,Si,(1S953)			
Q 31	Di,breakdown,(RD6.2EB)	5.8 to 6.6V,400mW		
Q 32	Tr,Si,NPN,(2SC1008)			
Q 33	Rectifier,(RB-152-LFB)			
Q 34	IC,(TA-7179P)			
Q 35	Tr,Si,NPN,(2SC943)			
Q 36	Di,brrakdown,(RD7.5EB)	7.0 to 7.9V,400mW		
Q 37	Tr,Si,PNP,(2SA603)			
Q 38	Di,breakdown,(RD7-5EB)	7.0 to 7.9V,400mW		
Q 39	IC,(TA7179P)			
Q 40	IC,(74LS04)			
Q 41	Not assigned			
Q 42	Di,Si,(1S953)			
Q 43	Di,Si,(1S953)			
Q 44	Di,Si,(1S953)			
Q 45	Di,Si,(1S953)			
Q 46	Di,Si,(1S953)			
Q 47	Di,Si,(1S953)			
R 1	MF,(RN05C2B1001D)	1kΩ,±0.5%,1/8W		
R 2	CF,(ARD25T223J)	22kΩ,±5%,1/4W		
R 3	CF,(ARD25T473J)	47kΩ,±5%,1/4W		
R 4	MF,(RN05C2B1001D)	1kΩ,±0.5%,1/8W		
R 5	MF,(RN05C2B1001D)	1kΩ,±0.5%,1/8W		
R 6	MF,(RN14K2E1003D)	100kΩ,±0.5%,1/4W		
R 7	MF,(RN052B1102D)	11kΩ,±0.5%,1/8W		
R 8	MF,(RN052B1110D)	111Ω,±0.5%,1/8W		
R 9	MF,(RN052B1001D)	1kΩ,±0.5%,1/8W		
R 10	MF,(RN052E1003D)	100kΩ,±0.5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF POWER SOURCE, AMPLIFIER SECTION

CKT REF	DESCRIPTION	RATING		NOTE
R 11	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 12	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 13	MF,(RN05C2B1002D)	10kΩ,±0.5%,1/8W		
R 14	MF,(RN05C2B1001D)	1kΩ,±0.5%,1/8W		
R 15	MF,(RN05C2B1110D)	111Ω,±0.5%,1/8W		
R 16	MF,(RN05C2B1001D)	1kΩ,±0.5%,1/8W		
R 17	MF,(RN05C2E1003D)	100kΩ,±0.5%,1/4W		
R 18	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 19	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 20	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 21	MF,(RN14K2E2002D)	20kΩ,±0.5%,1/4W		
R 22	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 23	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 24	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 25	MF,(RN05C2B2002D)	20kΩ,±0.5%,1/8W		
R 26	CF,(ARD25T823J)	82kΩ,±5%,1/4W		
R 27	CF,(ARD25T223J)	22kΩ,±5%,1/4W		
R 28	CF,(ARD25T222J)	2.2kΩ,±5%,1/4W		
R 29	CF,(ARD25T222J)	2.2kΩ,±5%,1/4W		
R 30	CF,(ARD25T223J)	22kΩ,±5%,1/4W		
R 31	CF,(ARD25T823J)	82kΩ,±5%,1/4W		
R 32	MF,(RN05C2B1002D)	10kΩ,±0.5%,1/8W		
R 33	Not assigned			
R 34	Var,MF,(RJ-6P 20kΩ)	Max.20kΩ		
R 35	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 36	CF,(ARD25T224J)	220kΩ,±5%,1/4W		
R 37	CF,(ARD25T334J)	330kΩ,±5%,1/4W		
R 38	CF,(ARD25T104J)	100kΩ,±5%,1/4W		
R 39	Var,MF,(RJ-6P 20kΩ)	Max.20kΩ		
R 40	CF,(ARD25T392J)	3.9kΩ,±5%,1/4W		
R 41	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 42	CF,(ARD25T183J)	18kΩ,±5%,1/4W		
R 43	Var,MF,(RJ-6P 5KΩ)	Max.5kΩ		
R 44	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 45	CF,(ARD25T104J)	100kΩ,±5%,1/4W		
R 46	CF,(ARD25T104J)	100kΩ,±5%,1/4W		
R 47	CF,(ARD25T104J)	100kΩ,±5%,1/4W		
R 48	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 49	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 50	Var,MF,(RJ-6P 20kΩ)	Max.20kΩ		
R 51	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 52	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 53	CF,(ARD25T223J)	22kΩ,±5%,1/4W		
R 54	CF,(ARD25T473J)	47kΩ,±5%,1/4W		
R 55	CF,(ARD25T102J)	1kΩ,±5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF POWER SOURCE, AMPLIFIER SECTION

CKT REF	DESCRIPTION	RATING		NOTE
R 56	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 57	CF,(ARD25T101J)	100Ω,±5%,1/4W		
R 58	MF,(RN14K2E1000D)	100Ω,±0.5%,1/4W		
R 59	MF,(RN14K2E1001D)	1kΩ,±0.5%,1/4W		
R 60	MF,(RN14K2E1002D)	10kΩ,±0.5%,1/4W		
R 61	MF,(RN14K2E1003D)	100kΩ,±0.5%,1/4W		
R 62	MF,(GS1/4B1MΩF)	1MΩ,±1%,1/4W		
R 63	MF,(GS1/4B10MΩF)	10MΩ,±1%,1/4W		
R 64	MF,(RN05C2B9902D)	99kΩ,±0.5%,1/8W		
R 65	MF,(RN14K2E1001D)	1kΩ,±0.5%,1/4W		
R 66	MF,(RN14K2E1001D)	1kΩ,±0.5%,1/4W		
R 67	Not assigned			
R 68	MF,(GS1/4B1MΩF)	1MΩ,±1%,1/4W		
R 69	MF,(RN14K2E1003D)	100kΩ,±0.5%,1/4W		
R 70	CF,(ARD25T101J)	100Ω,±5%,1/4W		
R 71	CF,(ARD25T105J)	1MΩ,±5%,1/4W		
R 72	Var,MF, (RG161P20SB10kΩM)	Max.10kΩ		
R 73	Not assigned			
R 74	MF,(RN14K2E4872D)	48.7kΩ,±0.5%,1/4W		
R 75	MF,(RN05C2E9901D)	9.9kΩ,±0.5%,1/4W		
R 76	MF,(RN14K2E1003D)	100kΩ,±0.5%,1/4W		
R 77	Var,MF,(RJ-6P 2KΩ)	Max.2kΩ		
R 78	MF,(RN14k2E6812D)	68.1kΩ,±0.5%,1/4W		
R 79	MF,(RN14K2E1000D)	100Ω,±0.5%,1/4W		
R 80	MF,(RN14K2E.001D)	1kΩ,±0.5%,1/4W		
R 81	Var,MF,(RJ-6P 20KΩ)	Max.20kΩ		
R 82	CF,(ARD25T101J)	100Ω,±5%,1/4W		
R 83	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 84	Var,MF,(RJ-6P 20KΩ)	Max.20kΩ		
R 85	Var,MF,(RJ-6P 10kΩ)	Max.10kΩ		
R 86	CF,(ARD25T101J)	100Ω,±5%,1/4W		
R 87	Var,MF,(RJ-6P 5KΩ)	Max.5kΩ		
R 88	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 89	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 90	CF,(ARD25T332J)	3.3kΩ,±5%,1/4W		
R 91	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 92	CF,(ARD25T105J)	1MΩ,±5%,1/4W		
R 93	CF,(ARD25T101J)	100Ω,±5%,1/4W		
R 94	CF,(ARD25T182J)	1.8kΩ,±5%,1/4W		
R 95	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 96	CF,(ARD25T4R7J)	4.7Ω,±5%,1/4W		
R 97	CF,(ARD25T153J)	15kΩ,±5%,1/4W		
R 98	CF,(ARD25T153J)	15KΩ,±5%,1/4W		
R 99	CF,(ARD25T4R7J)	4.7Ω,±5%,1/4W		
R100	CF,(ARD25T152J)	1.5kΩ,±5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF POWER SOURCE, AMPLIFIER SECTION

CKT REF	DESCRIPTION	RATING		NOTE
R101	CF,(ARD25T152J)	1.5kΩ,±5%,1/4W		
R102	CF,(ARD25T182J)	1.8kΩ,±5%,1/4W		
R103	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R104	CF,(ARD25T4R7J)	4.7Ω,±5%,1/4W		
R105	CF,(ARD25T153J)	15kΩ,±5%,1/4W		
R106	CF,(ARD25T153J)	15kΩ,±5%,1/4W		
R107	CF,(ARD25T4R7J)	4.7Ω,±5%,1/4W		
R108	Var,MF,(RJ-6P 10kΩ)	Max.10kΩ		
R109	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R110	CF,(ARD25T472J)	4.7kΩ,±5%,1/4W		
R111	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
T 1	Trans,(ST-26)			
T 2	Trans,(439T14952)	26VA		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF CONTROL CIRCUIT

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Plast(ECQ-M1H 104KZ)	0.1μF,±10%,50V		
C 2	Plast(ECQ-M1H 104KZ)	0.1μF,±10%,50V		
C 3	Tant,(CS02H1V010M)	1μF,±20%,35V		
C 4	Cer,(CK4501H103MY)	0.01μF,±20%,50V		
C 5	Plast,(ECQ-MH *KZ)	0.047μ to 0.1μF, ±10%,50V		*
C 6	Plast,(ECQ-MH *KZ)	0.047μ to 0.1μF, ±10%,50V		*
C 7	Cer,(CC92CH1H*DY)	4 to 10pF,±0.5%,50V		*
C 8	Cer,(CK45D1H103MY)	0.01μF,±20%,50V		
C 9	Cer,(CK45D1H103MY)	0.01μF,±20%,50V		
C 10	Not assigned			
C 11	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 12	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 13	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 14	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 15	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 16	Cer,(CK45D1H102MY)	0.001μF,±20%,50V		
C 17	Cer,(CK45D1H102MY)	0.001μF,±20%,50V		
C 18	Tant,(CS02H1D150M)	15μF,±20%,20V		
C 19	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 20	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 21	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 22	Not assigned			
C 23	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 24	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 25	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 26	Tant,(CS02H1D2R2M)	2.2μF,±20%,20V		
C 27	Tant,(CS02H1D2R2M)	2.2μF,±20%,20V		
C 28	Tant,(CS02H1D2R2M)	2.2μF,±20%,20V		
C 29	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 30	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 31	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
J 1	Connector, (HIF3-40P-2.54DSA)			
J 2	Connector, (HIF23A-34D-AA10S)			
J 3	Not assigned			
J 4	Connector, (HIF3-20P-2.54DSA)			
Q 1	Di,breakdown,(RD5.1EB)	4.8 to 5.4V,400mW		
Q 2	Di,breakdown,(RD5.1EB)	4.8 to 5.4V,400mW		
Q 3	Not assigned			
Q 4	IC,(ICL7109CPL)			
Q 5	IC,(74S175)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF CONTROL CIRCUIT

CKT REF	DESCRIPTION	RATING		NOTE
Q 6	IC,(TC4508BP)			
Q 7	IC,(TC5012BP)			
Q 8	IC,(TC5012BP)			
Q 9	IC,(TC5012BP)			
Q 10	IC,(TC4042BP)			
Q 11	IC,(TC4042BP)			
Q 12	IC,(TC4042BP)			
Q 13	IC,(μPC6.0D)			
Q 14	IC,(μPD780C)			
Q 15	IC,(HM462716)			
Q 16	IC,(HM462716)			
Q 17	IC,(HM462716)			OPTION
Q 18	Not assigned			
Q 19	IC,(μPD5101LC)			
Q 20	IC,(μPD5101LC)			
Q 21	Di,Si,(1S953)			
Q 22	IC,(74LS04)			
Q 23	IC,(74LS00)			
Q 24	IC,(TC4042BP)			
Q 25	IC,(TC4042BP)			
Q 26	IC,(TC4514BP)			
Q 27	IC,(74LS00)			
Q 28	IC,(74LS00)			
Q 29	IC,(74LS00)			
Q 30	IC,(7404)			
Q 31	IC,(74LS00)			
Q 32	IC,(74LS138)			
Q 33	IC,(TC4042BP)			
Q 34	IC,(TC4027BP)			
Q 35	IC,(7407)			
Q 36	Not assigned			
Q 37	IC,(TC4042BP)			
Q 38	IC,(TC4052BP)			
R 1	CF,(ARD25T681J)	680Ω,±5%,1/4W		
R 2	MF,(RN14K2E4641D)	4.64kΩ,±0.5%,1/4W		
R 3	MF,(RN14K2E4641D)	4.64kΩ,±0.5%,1/4W		
R 4	MF,(RN14K2E1212D)	12.1kΩ,±0.5%,1/4W		
R 5	MF,(RN14K2E1003D)	100kΩ,±0.5%,1/4W		
R 6	CF,(ARD25T683J)	68kΩ,±5%,1/4W		
R 7	CF,(ARD25T104J)	100kΩ,±5%,1/4W		
R 8	CF,(ARD25T681J)	680Ω,±5%,1/4W		
R 9	CF,(ARD25T331J)	330Ω,±5%,1/4W		
R 10	Not assigned			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF CONTROL CIRCUIT

CKT REF	DESCRIPTION	RATING		NOTE
R 11	Single-in, line type, array,(IHR-8-223JS)	22kΩ×8,±5%,1/8W		
R 12	Single-in, line type, array,(IHR-10-332JA)	3.3kΩ×10,±5%,1/8W		
R 13	CF,(ARD25T472J)	4.7kΩ,±5%,1/4W		
R 14	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 15	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 16	CF,(ARD25T102J)	1kΩ,±5%,1/4W		
R 17	CF,(ARD25T221J)	220Ω,±5%,1/4W		
R 18	CF,(ARD25T221J)	220Ω,±5%,1/4W		
R 19	Single-in, line type, array,(IHR-10-472JA)	4.7kΩ×10,±5%,1/8W		
R 20	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 21	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 22	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 23	Var,MF,(RJ-6P 10kΩ)	Max.10kΩ		
R 24	MF,(RN14K2E4872D)	48.7kΩ,±0.5%,1/4W		
R 25	Var,MF,(RJ-6P 10kΩ)	Max.10kΩ		
R 26	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 27	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 28	CF,(ARD25T103J)	10kΩ,±5%,1/4W		
R 29	CF,(ARD25T103J)	10kΩ,±5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF DISPLAY CIRCUIT

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Cer,(CK924F1H104Z)	0.1μF,±10%,50V		
C 2	Cer,(CK924F1H104Z)	0.1μF,±10%,50V		
C 3	Cer,(CK924F1H104Z)	0.1μF,±10%,50V		
J 1	Connector, (HIF3-34P-2.54DSA)			
M 1	Meter,(44M65700)			
Q 1	IC,(μPA56C)			
Q 2	IC,(74145)			
Q 3	IC,(74145)			
Q 4	Display,(5082-7736)			
Q 5	Display,(5082-7740)			
Q 6	Display,(5082-7740)			
Q 7	Display,(5082-7740)			
Q 8	Display,(5082-7740)			
Q 9	Display,(5082-7736)			
Q 10	Display,(5082-7740)			
Q 11	Display,(5082-7740)			
Q 12	Display,(5082-7740)			
Q 13	Display,(5082-7740)			
Q 14	Not assigned			
Q 15 to Q 24	LED,(SR505D)			
Q 25	Tr,Si,NPN,(2SC1833)			
R 1 to R 2	CF,(ARD25T330J)	33Ω,±5%,1/4W		
S 1	Key,(KEC11901)			
S 2	Not assigned			
S 3	Key,(KEC11901)			
S 4	Key,(KEC11901)			
S 5	Not assigned			
S 6	Key,(KEC10001)			
S 7	Key,(KEC10001)			
S 8	Key,(KEC11901)			
S 9	Key,(KEC10001)			
S 10	Key,(KEC10001)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF DISPLAY CIRCUIT

CKT REF	DESCRIPTION	RATING		NOTE
S 11	Key,(KEC10001)			
S 12	Pushbutton,(8631CBE)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF 5V POWER SOURCE

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Elect,(CE04W1V4R7)	4.7μF,+100/-10%,35V		
C 2	Elect,(CE04W1V220)	22μF,+100/-10%,35V		
C 3	Plast,(ECQ-M05 104KZ)	0.1μF,±10%,50V		
C 4	Elect,(CE04W1A471)	470μF,+100/-10%,10V		
C 5	Elect,(CE04W1E471)	470μF,+100/-10%,25V		
C 6	Elect,(CE04W1E471)	470μF,+100/-10%,25V		
L 1	Coil,(SF-T12-150)	1mH,1.5A		
L 2	Coil,(SF-T8-50D)	130μH		
Q 1	Tr,Si,PNP,(2SA708)			
Q 2	Di,Si,(1S1834)			
Q 3	Di,Si,(1S1834)			
Q 4	IC,(μPC141C)			
Q 5	Di,breakdown,(RD5.1EB)	4.8 to 5.4V,400mW		
Q 6	Rectifier,(M4C-31-12)	3A		
R 1	CF,(ARD25T680J)	68Ω,±5%,1/4W		
R 2	CF,(ARD25T105J)	1MΩ,±5%,1/4W		
R 3	CF,(ARD25T152J)	1.5kΩ,±5%,1/4W		
R 4	CF,(ARD25T220J)	22Ω,±5%,1/4W		
R 5	CF,(ARD25T682J)	6.8kΩ,±5%,1/4W		
R 6	Var,MF,(RJ-6S 1kΩ)	Max.1kΩ		
R 7	CF,(ARD25T332J)	3.3kΩ,±5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

C.L. OF GP-IB (OPTION)

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Elect,(CE04W1V100)	10μF,+100/-10%,35V		
C 2	Elect,(CA92C1C1R000R56)	1μF,16V		
C 3	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 4	Plast,(ECQ-M1H104KZ)	0.1μF,±10%,50V		
C 5	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 6	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 7	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 8	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C 9	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
C10	Cer,(CK924F1H104Z)	0.1μF,+80/-20%,50V		
J 1	Connector, (57L-20240-27CD5)	24P		
J 2	Connector, (HIF23A-20D-AA10S)	20P		
Q 1	IC,(74LS368A)			
Q 2	IC,(P8291)			
Q 3	IC,(74LS08)			
Q 4	IC,(74LS04)			
Q 5	IC,(74LS04)			
Q 6	IC,(74LS04)			
Q 7	IC,(84LS368A)			
Q 8	IC,(74LS14)			
Q 9	IC,(7438)			
Q10	IC,(74LS245)			
Q11	IC,(7438)			
Q12	IC,(7438)			
Q13	IC,(74LS368A)			
Q14	IC,(74LS04)			
R 1	Single-in,line type, array,(IHR-8-622JA)	6.2kΩ x 8,±5%,1/4W		
R 2	Single-in,line type, array,(IHR-8-302JA)	3kΩ x 8,±5%,1/4W		
R 3	Single-in,line type, array,(IHR-8-622JA)	6.2kΩ x 8,±5%,1/4W		
R 4	Single-in,line type, array,(IHR-8-302JA)	3kΩ x 8,±5%,1/4W		
R 5	Single-in,line type, array,(IHR-8-622JA)	6.2kΩ x 8,±5%,1/4W		
R 6	CF,(ARD25T682J)	6.8kΩ,±5%,1/4W		
S 1	Switch,(BP-8)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA95A

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Cer, (CC92CH1H470JY)	47pF,±5%,50V		
C 2	Cer, (CC92CH1H330JY)	33pF,±5%,50V		
C 3	Plast, (ECQ-M1H223KZ)	0.022μF,±10%,50V		
C 4	Plast, (ECQ-M1H104KZ)	0.1μF,±10%,50V		
C 5	Not assigned			
C 6	Tant, (CS02H1C220M)	22μF,±20%,16V		
C 7	Tant, (CS02H1C220M)	22μF,±20%,16V		
C 8	Cer, (CC92CH1H020CY)	2pF,±0.25pF,50V		
J 1	Connector (R15A-17R-16PB)			
K 1	Read relay, (REO113)			
K 2	Read relay, (REO113)			
Q 1	Di, photo, (S-1223-01)			
Q 2	IC, (TDB0156CM)			
R 1	MF, (GS1/2B 50MΩF)	50MΩ,±1%,1/2W		
R 2	MF, (GS1/4B 1MΩF)	1MΩ,±1%,1/4W		
R 3	MF, (RN05C2B1001D)	1KΩ,±0.5%,1/4W		
R 4	Not assigned			
R 5	Not assigned			
R 6	Not assigned			
R 7	MF, (RN14K2E5361D)	5.36KΩ,±0.5%,1/4W		
R 8	Var, MF, (POT1102P-1-502)	5KΩ,1/2W		
R 9	MF, (RN14K2E2001D)	2KΩ,±0.5%,1/4W		
R 10	MF, (RN14K2E4750D)	4.75KΩ,±0.5%,1/4W		
R 11	Var, MF, (POT1102P-1-102)	1KΩ,1/2W		
R 12	MF, (RN14K2E2000D)	200Ω,±0.5%,1/4W		
R 13	MF, (RN14K2E1001D)	1KΩ,±0.5%,1/4W		
R 14	Var, MF, (POT1102P-1-203)	20KΩ,1/2W		
R 15	Not assigned			
R 16	CF, (ARD25T221J)	220Ω,±5%,1/4W		
R 17	CF, (ARD25T221J)	220Ω,±5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA95A

CKT REF	DESCRIPTION	RATING		NOTE
Z 1	Tuning fork, (44H63972)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA96A

CKT REF	DESCRIPTION	RATING		NOTE
C 1	Cer, (CC92CH1H470JY)	47pF,±5%,50V		
C 2	Cer, (CC92CH1H330JY)	33pF,±5%,50V		
C 3	Plast, (ECQ-M1H223KZ)	0.022μF,±10%,50V		
C 4	Plast, (ECQ-M1H104KZ)	0.1μF,±10%,50V		
C 5	Not assigned			
C 6	Tant, (CS02H1C220M)	22μF,±20%,16V		
C 7	Tant, (CS02H1C220M)	22μF,±20%,16V		
C 8	Cer, (CC92CH1H020CY)	2pF,±0.25pF,50V		
J 1	Connector (R15A-17R-16PB)			
K 1	Read relay, (RE0113)			
K 2	Read relay, (RE0113)			
Q 1	Di, photo, (FPD140-M3)			
Q 2	IC, (TDB0156CM)			
R 1	MF, (GS1/2B 50MΩF)	50MΩ,±1%,1/2W		
R 2	MF, (GS1/4B 1MΩF)	1MΩ,±1%,1/4W		
R 3	MF, (RN05C2B1001D)	1KΩ,±0.5%,1/4W		
R 4	CF, (ARD25T103J)	10KΩ,±5%,1/4W		
R 5	Not assigned			
R 6	Not assigned			
R 7	MF, (RN14K2E5361D)	5.36KΩ,±0.5%,1/4W		
R 8	Var, MF, (POT1102P-1-502)	5KΩ,1/2W		
R 9	MF, (RN14K2E2001D)	2KΩ,±0.5%,1/4W		
R 10	MF, (RN14K2E4750D)	4.75KΩ,±0.5%,1/4W		
R 11	Var, MF, (POT1102P-1-102)	1KΩ,1/2W		
R 12	MF, (RN14K2E2000D)	200Ω,±0.5%,1/4W		
R 13	MF, (RN14K2E1001D)	1KΩ,±0.5%,1/4W		
R 14	Var, MF, (POT1102P-1-203)	20KΩ,1/2W		
R 15	Not assigned			
R 16	CF, (ARD25T221J)	220Ω,±5%,1/4W		
R 17	CF, (ARD25T221J)	220Ω,±5%,1/4W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA96A

CKT REF	DESCRIPTION	RATING		NOTE
R18	Var,MF,(RJ-6S 20kΩ)	20kΩ,1/2W		
Z1	Tuning fork, (44H63972)			

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA97A

CKT REF	DESCRIPTION	RATING		NOTE
J 1	Connector, (HR10-7R-6P)			
Q 1	PV-444A			
R 1	MF, (RN14K2E1002D)	10KΩ,±0.5%,1/4W		
R 2	Var, MF, (POT1102S-1-203)	20KΩ,1/2W		

( ): Manufacturer's part number

* : Selected at factory

COMPONENT LIST OF OPTICAL SENSOR MA98A

CKT REF	DESCRIPTION	RATING		NOTE
J 1	Connector, (HR10-7R-6P)			
Q 1	Diode, photo (J-16)			
R 1	MF, (RN14K2E4991D)	4.99kΩ, ±0.5%,1/4W		
R 2	Var, MF,(POT1102S-1-203)	20KΩ,1/2W		

( ): Manufacturer's part number

* : Selected at factory

SECTION 9

DISASSEMBLY AND REASSEMBLY

The procedure for disassembly is shown. For reassembling, reverse this procedure.

(1) How to remove top cover (5) and bottom cover (6)

1. Remove two screws (15).
2. If GP-IB (option) is mounted, remove two screws (16).
3. Pull off the top cover, and also pull off the bottom cover.

(2) How to remove Z2 power source amplifier P.C. board (10).

1. Remove seven screws (20).
2. Disconnect two connectors.
3. Pull the P.C. board slantly rearward.

(3) How to remove Z5 GP-IB P.C. board (13).

1. Remove four screws (23).
2. Disconnect one connector.
3. Remove the P.C. board upward.

(4) How to remove Z3 control circuit P.C. board (11).

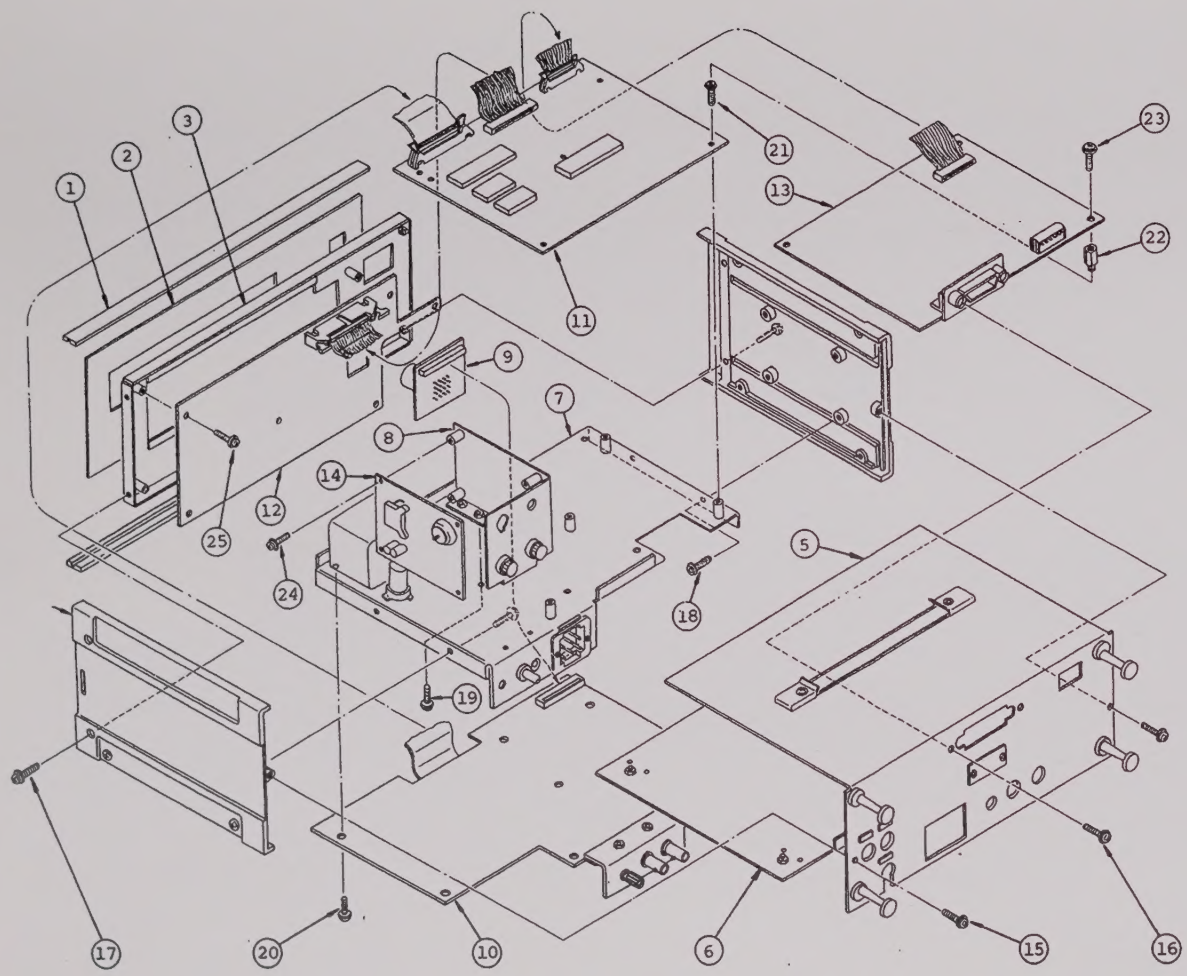
1. Remove GP-IB P.C. board in the order of (3).
2. If GP-IB is mounted, supports (22) are used in place of screws (21). Remove four supports (22).
   If it is not, remove four screws (21).
3. Disconnect two connectors.
4. Pull the P.C. board upward.

(5) How to remove Z4 display P.C. board (12).

1. Remove Z2 P.C. board in the order of (2).
2. Remove four screws (17) and four screws (18).
3. Pull off side board (4) to the side.
4. Remove two sashes (1) and front panel (2).
5. Disconnect connectors of Z4.
6. Remove six screws (25).
7. Remove the P.C. board.

(6) How to remove Z7 +5 V power source P.C. board (14).

1. Perform steps 1 ∿ 3 of (5).
2. Remove four screws (24).
3. Remove the P.C. board.
4. For replacing the P.C. board, remove wirings using a soldering iron.



No.	Discription	Q'ty
①	Sash	2
②	Front Pannel	1
③	Sub Pannel	1
④	Side Board	2
⑤	Top Cover	1
⑥	Bottom Cover	1
⑦	Chassis	1
⑧	Sub-chassis	1
⑨	Z1 Connector Board P.C. Board	1
⑩	Z2 Amplifier Section P.C. Board	1
⑪	Z3 Control Circuit P.C. Board	1
⑫	Z4 Display Circuit P.C. Board	1
⑬	Z5 GP-IB P.C. Board	2
⑭	Z7 5V Power Source P.C. Board	2
⑮	Screw	2
⑯	Screw	4
⑰	Screw	4
⑱	Screw	4
⑲	Screw	4
⑳	Screw	7
㉑	Screw	7
㉒	Screw, Support	4
㉓	Screw	4
㉔	Screw	4
㉕	Screw	6

Fig. 9-1 Assemble

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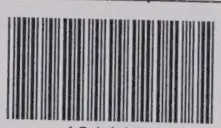

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